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ELECTRICAL REVIEW

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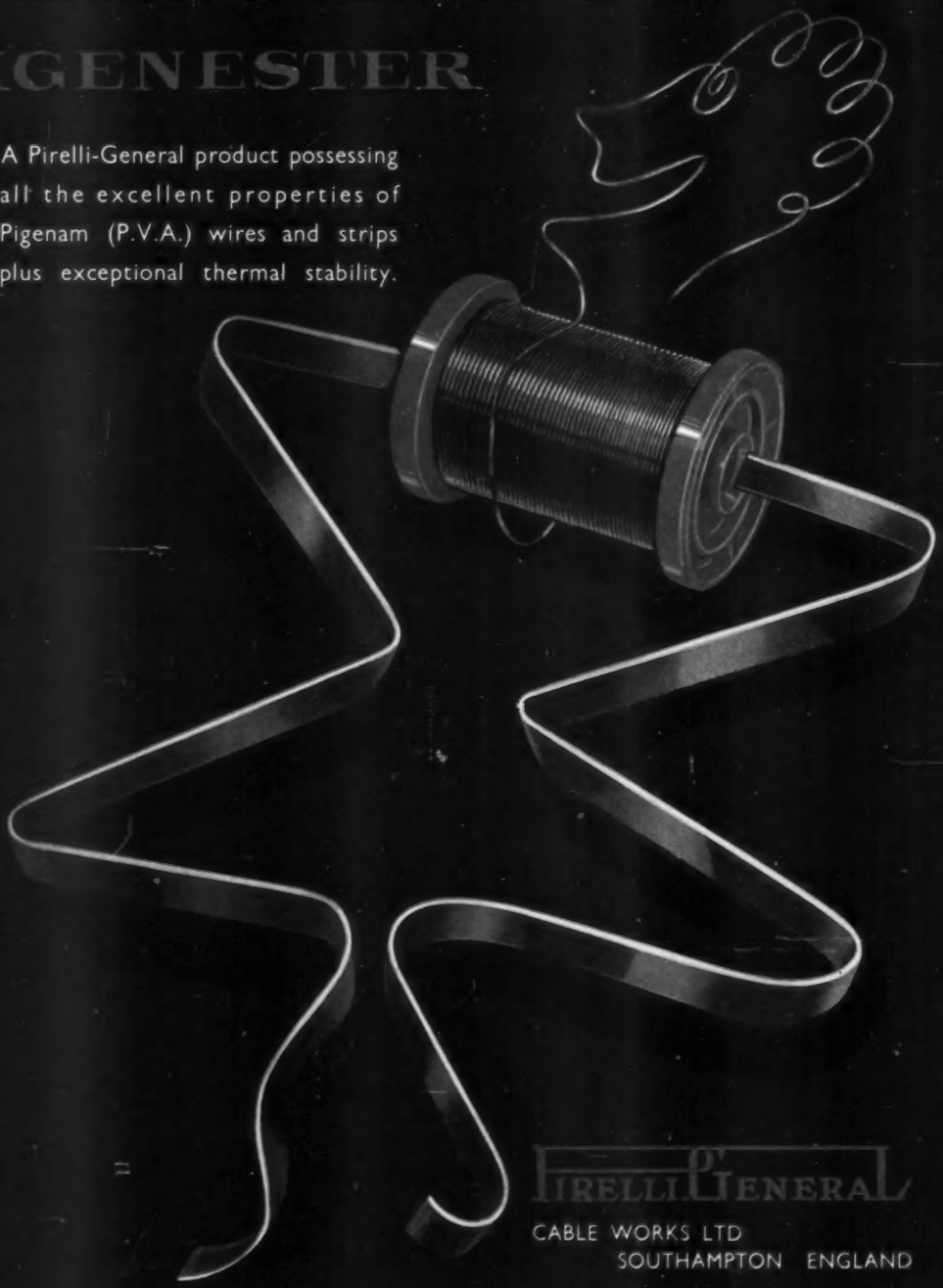

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ELECTRICAL REVIEW

28 August 1959 Vol. 165 No. 3 Established 1872

Electrical Fair Trading

THE last edition of the British Electrical Industry Fair Trading Policy was issued by the Electrical Fair Trading Council (Sardinia House, Kingsway, London, W.C.2) in September, 1955. Since that date the Restrictive Trade Practices Act has come into force and although there is nothing restrictive about the Policy it was thought to be necessary to register it with the Registrar of Restrictive Trade Practices.

Mr. T. W. Heather (chairman of the Council) reminded us at a recent meeting that although the Policy was originally conceived, in 1933, as a binding agreement of obligations and sanctions entered into by the various parties, this idea was soon abandoned. After the war it was made quite clear that the Policy was a code of ethics and guidance for voluntary adoption. The Council had no power, or desire, to enforce its observance. Nevertheless the wording of the earlier editions was open to misconstruction and accordingly it was decided to issue a new edition (the seventh) with necessary revisions and to lodge it with the Registrar in the place of the former text.

At the same time the opportunity was taken of dealing with the " user problem " which has been the cause of much argument in the past. Hitherto the " Classifications and Definitions " of the Policy have defined the electrical manufacturer, electrical wholesaler, electrical supplier, electricity supply authority, contractor, retailer and Government Department. These definitions remain virtually unchanged in the new edition but the class formerly described as " Commercial & Industrial Buyers " (" Special Large Buyers " or " Recognised Users ") is now covered by a heading " Commercial, Industrial or Other Large Users " and the definition is simplified. To qualify under this heading a person, persons, company or firm, not engaged in installing and selling electrical products, must have a large annual requirement of such products, needing the permanent employment of a qualified electrical staff. It is provided that recognition of a firm, etc., under this heading by a particular section or sections of the industry does not imply recognition by other sections.

In the schedules to the earlier editions of the Policy the rates of discount for electricity supply authorities, contractors and retailers have been given, as they are in the new Policy. But they also specified terms for special large buyers and recognised users, whereas now the terms are left for decision by the manufacturer or supplier concerned. An attempt has been made to

distinguish between large quantity buying and other purchases by Government Departments. Hire-purchase transactions are again covered but a note is added that the Council considers three years to be a reasonable term for repayment, except where special conditions apply.

It is noteworthy that the use of the term "recommendations" has been avoided in the new edition. Throughout emphasis is placed on guidance and Mr. Heather rightly remarked that general rules of guidance are more necessary to the industry than ever before. There are signs that the breaking up of trade associations is likely to lead to anarchy and reckless discount competition which will not only damage the industry but rapidly result in a deterioration of service to the public and in the quality of the product.

FOREIGN PLANT IN AMERICA

American manufacturers of heavy electrical plant suffered a severe drop in orders during last year's recession and it is not difficult to appreciate their desire for a greater degree of protection against foreign competition. The Office of Civil and Defense Mobilisation has, however, rejected their claim that imports of large hydraulic turbines, generators, transformers and switchgear represent a threat to United States security. The "threat" is put into perspective by the statement that in the seven years ended July, 1958, the number of these equipments delivered or on order from foreign firms was 361 compared with a domestic production of 30,000. Out of a total of 3,200 power stations, 800 are considered to be essential to security and foreign equipment is installed in less than 5 per cent of these.

Though most welcome, the Agency's decision does not appear to greatly alter the position of foreign suppliers. Local manufacturers are still protected by import tariffs and the provisions of the Buy American Act which gives them a 12 per cent price advantage. The Agency now recommends that tenders for Federal projects should be accepted only from firms with repair facilities in North America. It is also to keep imports of hydraulic turbines under review. Though this does not mean that the award of individual contracts will be open to appeal on security grounds, as happened with the Greer's Ferry turbines, restrictions may be imposed if foreign firms obtain more than an unspecified proportion of the work. Unfortunately the problem is not settled by the Agency's decision. The controversy, with its disturbing repercussions on good relations between the two countries, is likely to be renewed each time American manufacturers are outbid and it will no doubt be further stimulated by the Agency's forthcoming report on the imports of steam turbo-generators.

TECHNICAL INFORMATION

The dissemination of technical information may be carried out in a number of ways, one of the most popular being the presentation of papers to institutions, societies and other authoritative bodies. Normally these papers are prepared by experienced specialists in a particular field and the information given in them is of the utmost value to other senior engineers and scientists. It has occurred to us, however, that many not-so-senior members of the electrical and other professions would appreciate papers of a less advanced nature, enabling an understanding of the processes, and problems, at their own level in other fields to be obtained. One incidental advantage would be the emergence of new authors, hitherto reluctant to air knowledge or opinions which they have felt to be somewhat restricted, and early experience gained in the presentation of this type of paper would be invaluable in later preparation of more advanced work. In this connection we would commend the papers read to the Graduate and Student Sections of the I.E.E. and the articles which appear in the Students' Quarterly Journal.

I.E.E. FINANCES

In our comment under this heading in our issue of 14th August, we remarked that it appeared that members thought that the Institution's financial position should be improved by economies rather than by higher subscriptions. Even though the Council's proposal to increase subscriptions was finally confirmed at another special general meeting of the Institution of Electrical Engineers on 18th August, we think that our comment was not altogether wrong. When voting, many members no doubt felt torn between a decision against the proposal on the principle of improving finances by economies or a vote for the increases to avoid damaging the standing of the Institution.

During the meeting (the results are recorded elsewhere in this issue) the President stated that he had decided to recommend the Council to set up a special committee to consider members' proposals for economies and other matters. Although we feel that members will not be completely satisfied, it is to be hoped that the recommendations of the proposed committee, if adopted, will go some way towards meeting their desires.

NUCLEAR REACTOR DESIGN

The new Atomic Energy Establishment, Winfrith, which is described in this issue, is being set up specifically to study new ideas and provide basic design data for application to power generation. A vast amount of fundamental work is necessary to support a broadly based reactor programme between the new idea stage and the construction of a prototype. The main steps along this road include theoretical feasibility studies, basic reactor physics studies, using non-critical and critical assemblies of fissile and moderator materials but without the release of significant amounts of power, technological research and development of materials, studies of irradiation effects on them, corrosion studies, the development of control and instrumentation systems, and many engineering design problems, including those of heat transfer and mass transfer around systems.

The results of these studies may or may not show that it would be of interest to take a given system to the reactor experiment stage or beyond to a prototype reactor. If useful possibilities are indicated the engineering design of a system which might operate in the region of one to ten megawatts is worked out and the reactor experiment is proceeded with.

Electronics in Aviation

By H. ZEFFERT, A.F.R.Ae.S., Associate I.E.E., Mem.A.I.E.E.*

The amount of electronic equipment installed in modern aircraft is steadily increasing; it ranges from servo-mechanisms to navigational equipment and flight systems. The factors which have a bearing on this growth are surveyed, including aircraft type, its performance characteristics and operational environment. The various electrical power supply requirements are then discussed and a review is made of the ways in which the power is utilised by electronic apparatus

ONE has been constantly reminded of the spectacular growth of aviation from the early attempts some 50 years ago, up to the present era of jet travel. The steady growth in the utilisation of electrical power and its development on modern aircraft has not been so apparent. The most recent British aircraft, the Vickers "Vanguard," generates no less than 300 kVA, while its antecedent, the "Viking," built in 1945 required only 6 kW. This increase in power has partially been made necessary by such improved passenger amenities as cabin air conditioning and lighting, and the installation of an elaborate electrical galley. But lesser-known applications of electrical power have also increased considerably, including the operation of a multitude of electronic devices ranging from the most intricate navigational equipment to simple push-pull servo-mechanisms for various systems required in flight.

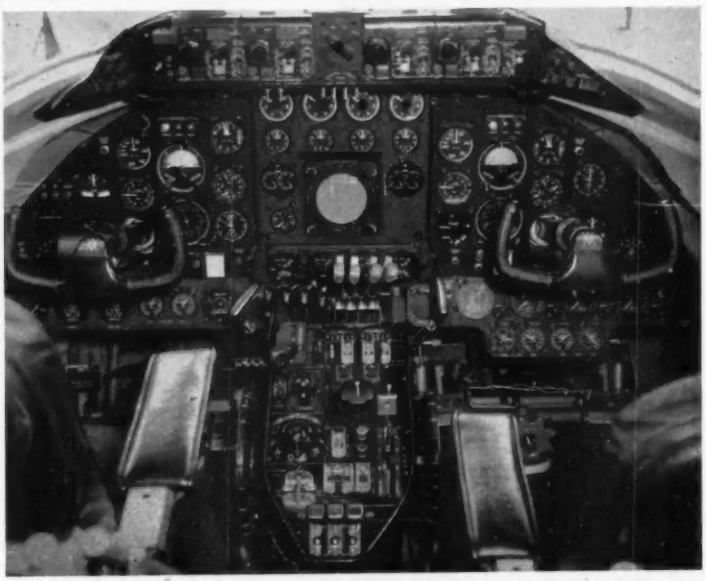
It has become increasingly difficult to differentiate between electronics and electrics in recent years owing to the development of the magnetic amplifier and latterly the transistor. In earlier times this differentiation was made by terming any component using thermionic valves as electronic equipment, but nowadays another line of demarcation is necessary and in the United States the word "avionics" has been coined, an Americanism designating electronic equipment used in the communication, navigation, auto-pilot, fuel gauging and temperature control fields. The dividing line is arbitrary, but the groups mentioned represent typical items coming under this heading.

Many factors have a bearing on the utilisation growth and these are briefly surveyed to show why many of the requirements exist and why they are constantly changing.

Aircraft Types

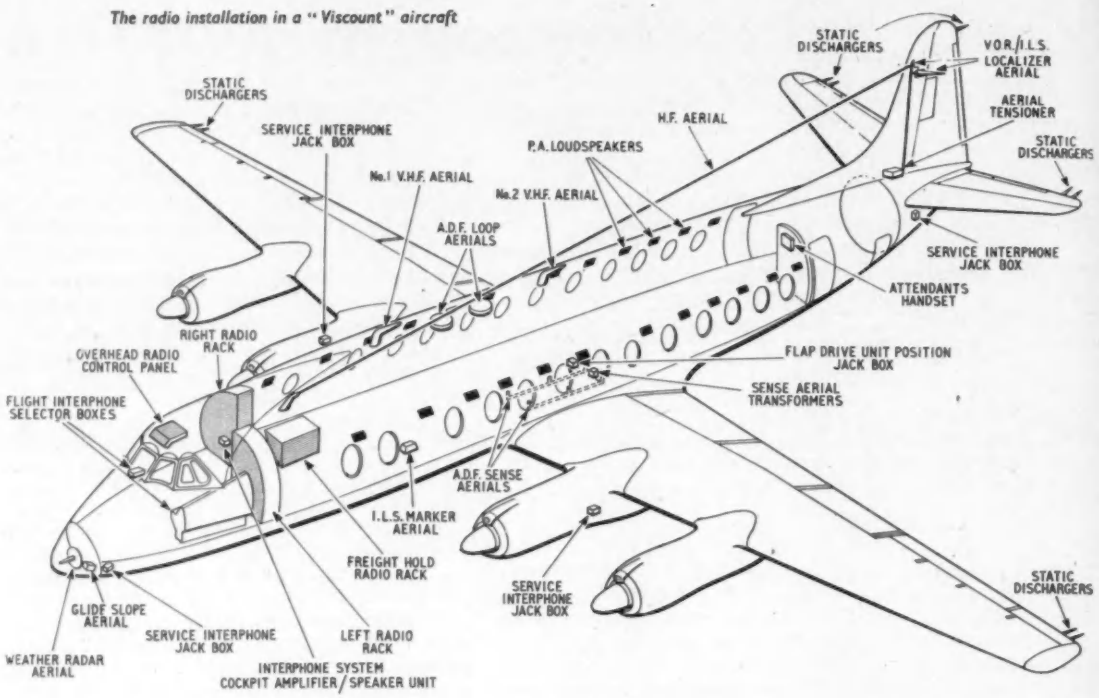
Aircraft are built to perform many duties covering a wide range of conditions and it is therefore necessary to consider the type and role of the aircraft, its range and speed, and the area in which it will operate. A small privately owned light aircraft may only require simple short-range communication, whereas the medium- and long-range civil airliners require the most comprehensive communication equipment for transmitting and receiving control information wherever they may be. These aircraft will also require, dependent upon their routes, varying types of navigational equipment which, on the trans-oceanic routes, reaches a high degree of complexity and necessitates the fitting of dual installations to ensure the utmost reliability. Most large modern aircraft, both military and civil, are fitted with some form of auto-pilot, equipments which have developed considerably since the earliest wartime days. The necessity to obtain increasingly fast response time has inevitably resulted in the inclusion of electronic computers to resolve the various sensor signals and thereby control the aircraft under turbulent conditions, maintaining the correct heading and altitude. The traffic problem in modern large airports, particularly during poor visibility conditions, has for some time made the possibility of completely blind landing an aircraft desirable. We already have computer systems in daily operation which, when coupled to the instrument landing system, automatically control the aircraft on a 3 deg glidepath to within 150ft of the runway. Develop-

* Chief Electrical and Electronics Engineer, Vickers-Armstrongs (Aircraft), Ltd.



Electronics plays a large part in the presentation of information to the crew

The radio installation in a "Viscount" aircraft



ment work is now being undertaken on the next stage for incorporation in aircraft in the 1960 to 1970 era, enabling automatically controlled descent to within 50ft of the runway. This phase will be known as automatic flare-out, and a combination of electronic auto-pilot and instrument landing system information will be initially required, coupled, between 150ft and 50ft, with radio altimeter information and automatic throttle control. The last and final phase of full blind landing will require azimuthal information to steer the aircraft along the runway centre line. Several methods are envisaged for this operation, but, in general, a self-contained system within the aircraft is favoured, even though some monitor system is employed by ground control. It needs no imagination to realise that the safety requirements and integrity which must be built into such a system on whose continued working the aircraft's safety may depend, requires development and a safety ideal in electronic construction and connections far beyond anything at present accepted.

Radar also enters into the civil field providing weather information enabling the avoidance of storm centres and, with some equipments, the facility of terrain recognition. Military aircraft carry various types of radar equipment associated with their particular mission, enabling them to operate entirely without reference to ground stations for navigation and position.

Environment and Reliability

A wide range of environmental conditions are encountered which affect the design requirements of electronic equipment particularly with regard to complete reliability under all the climatic conditions which may be encountered. Ground ambient temperature conditions may be below −40 deg C, while an upper temperature of +50 deg C has to be catered for to meet the maximum tropical case. There are additionally local temperature zones within an aircraft which may produce exceptional conditions, usually associated with engine and de-icing installations. The soak temperature in a jet engine nacelle after shutdown on the ground can, for example, be in the region of 150 to 200 deg C. Fortunately, the more complex type of equipment is not required to work under these conditions, being normally housed within the aircraft hull, but occasionally some equipment must operate even under these conditions. The change in barometric pressure due to the aircraft's altitude can have a profound effect on the design of electronic equipment, because of the increased possibility of flashover and the effect of pressure cycling with the attendant risk of moisture accumulation.

In civil aircraft it is usual to carry the main navigational and communication equipment, together with auto-pilots, etc., within the pressurised hull, artificially creating favourable environmental conditions, though it is usual for such equipment to have an unpressurised operating ceiling to cover the possibility of depressurised flight during fault conditions. On military aircraft, pressure cabin areas are usually only large enough to contain the crew and the controls required to operate the aircraft, and electronic equipment may therefore be required to operate at heights of 60,000ft or more. The creation of an artificial environment by housing the equipment in pressurised containers has been developed to obtain reliability under these extreme conditions. Even with all these precautions the closest possible attention must be paid to the anti-corrosive finishes incorporated in equipment to combat the effects of moisture and fungus.

Another aspect of environment relates to acceleration and vibration. All equipment will be subjected to accelerations on take-off, cruising and landing. The effects of wind gusts must be taken into account and the aircraft itself zoned into areas of acceleration dependent on the position with relation to the flight axis. It is usual to build equipment mounted near the crew to withstand

stresses of 9 g for civil and 12 g for military aircraft. This is necessary to ensure that no equipment can break free during periods of high deceleration and injure the crew.

Vibration, whether produced by the engine, aerodynamically or by the operation of other equipment, remains a most difficult problem to combat in the design and construction of electronic equipment. It is usual for certain vibration envelopes to be specified in accordance with M.O.S. Spec. G.100, but unfortunately, much of the vibration information in existence falls far short of the knowledge which is required to meet conditions on the most modern types of aircraft. Considerable steps have been taken in the United States to analyse the frequencies and amplitudes of vibration on modern aircraft and this information will substantially alter many of the design requirements for future equipment. Sensitive equipment is frequently mounted on some form of anti-vibration mounting, but there are certain conditions of low-frequency high-amplitude oscillations which make this precaution useless and it is necessary to ascertain as early as possible the vibration characteristics of a particular aircraft if full electronic reliability is to be ensured. This is no easy task as it requires an adequately instrumented aircraft allocated to test work and of necessity must involve heavy financial outlay.

Marconi equipment at a radio operator's station

It is paradoxical that all of the special requirements must be met and yet the equipment must weigh the absolute minimum, certainly considerably less than any similar ground equipment. Airborne techniques have therefore been responsible for accelerating the development of magnetic amplifiers and transistors, resulting in major improvements in both the size and weight of modern electronic equipment for aircraft use. This is not without penalty, particularly with the use of transistors, for a cooling problem has been introduced by the high junction temperatures produced, which, for long life, must be kept within specified limits. It is therefore necessary on modern aircraft for equipment cooling to be integrated into the aircraft air-conditioning system and for the electronic equipment racks to be built in the form of a plenum chamber exhausted by special fans.

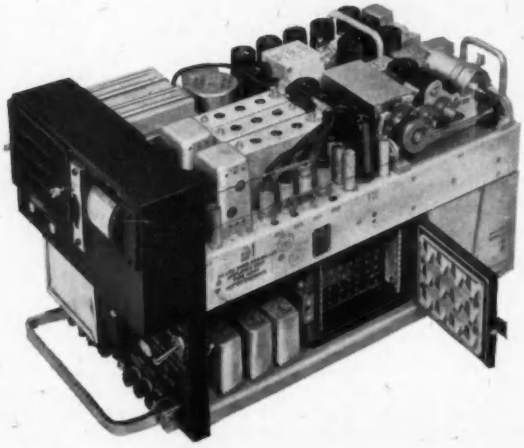
When all this is done the equipment in a modern aircraft should be capable of completely trouble-free operation for at least 1,000 hours and there is no reason why eventually a life far in excess of this figure should not be obtained.

Power Supply

Those familiar with the aircraft electrical field are aware of the many differing types of supply, voltages and frequencies used. Many of the requirements for these varied supplies have arisen through an unco-ordinated development policy and a lack of appreciation by many electronic designers of the relatively small percentage of power consumed by their equipments in relation to a total aircraft electrical system. This has resulted in small equipments often dictating the characteristics of total

The compact construction of airborne equipment is illustrated by the Elliott/Bendix transistorised v.h.f. communication and navigation equipment, comprising a v.h.f. transmitter and receiver, V.O.R. receiver, instrumentation unit and glide slope receiver, and . . . .

. . . . this interior view of a Standard Telephones & Cables h.f. communications receiver



power supplies in aircraft to obtain a small weight saving which in itself has been ridiculous when compared to the penalty paid in the total installation in its achievement. Aircraft supplies in current use include 28 and 112 V d.c., and 115 V, single- and three-phase, 400 c/s, 200 V, single- and three-phase, 400 c/s, and 80 and 115 V, single-phase, 1,600 c/s, a.c.

Furthermore, the missile field has attempted to enforce a new standard of 115/200 V, 2,400 c/s. In addition to this multitude of voltages, the basic supply frequency has been used as a reference in some equipment, requiring regulation to within $\pm\frac{1}{4}$ per cent. Since it is completely uneconomical, excluding the most exceptional cases, for one equipment only to be fed from any supply, the problem of control with various and varying loads makes such a requirement extremely onerous, and in most cases it is not the correct approach. There has been a large shift of opinion, particularly in the United States, towards the philosophy of a standard voltage and frequency, 200/115 V, 400 c/s, three-phase, with a frequency and voltage tolerance of approximately $\pm 2\frac{1}{2}$ per cent, and most modern equipment, both military and civil, is being developed to use the new standard. It is worth noting that the high frequencies used by the missile field are impracticable for aircraft installations of any size owing to impedance problems and the more serious difficulty of radiated interference.

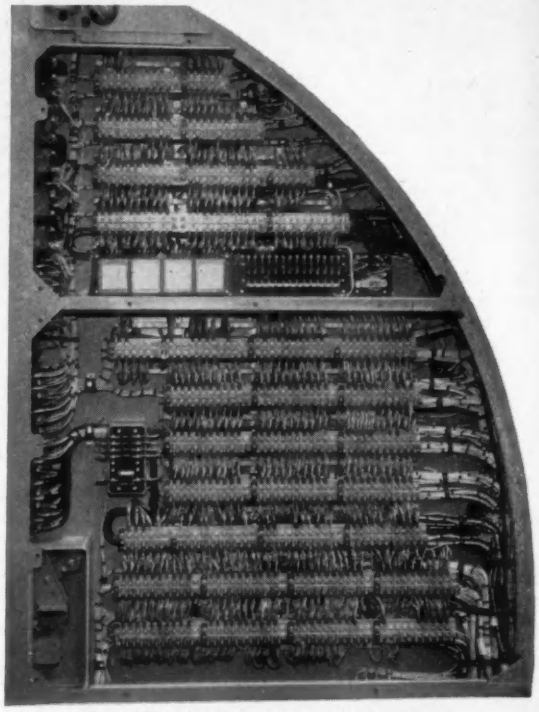
It is difficult to give any empirical total electronic load power supply requirement on aircraft owing to the variety of equipment carried even on the same type of aircraft operating in different areas. Much of the equipment used is dictated by the existence of particular ground facilities which vary widely throughout the world. As an example, the "Viscount 700" was originally equipped with two 500 VA invertors to supply the complete electronic load including the auto-pilot, based on a system with a total capacity of 24 kW d.c. In a later version, the "Viscount 800," power has been increased to a total of 36 kW d.c. while the total electronic load has been catered for by one 3,000 VA invertor with another as standby. On the "Vanguard," excluding the generation for de-icing, the total d.c. system capacity is 72 kW while the electronic supplies are now fed from two 3 kW a.c. invertors with an additional unit for standby.

It will be realised that, notwithstanding the tremendous growth in utilisation of electronic equipment, the requirement is still a reasonably small percentage of the aircraft's total power generation. There is, of course, with all these examples, a small d.c. requirement, but this is not large enough to affect the situation. On aircraft with a.c. main power generation, the situation is not changed except that the inefficiency of the conversion equipment from d.c. to a.c. is now no longer required in basic power and a reduction in total power requirements can be effected, but the electronic load remains a small proportion of the total generation.

It is paradoxical that, apart from the elimination of high altitude brush wear, the principal factor in changing from d.c. to a.c. in the aircraft power field has been the demand for the high voltages required within electronic equipment for the operation of thermionic valves. With the advent of the transistor, which requires a d.c. source, it will be interesting to view at some future date the disadvantage of the a.c. system from this aspect.

Communication

Various types of communication are to be found on modern aircraft. The very high frequency (v.h.f.) system is found on almost all aircraft, both military and civil, light and heavy, and is used for air-to-air or air-to-ground



Some of the circuits are taken to this junction box

radio telephony. The frequency range is between 100 and 150 Mc/s, controlled usually by crystal. Its use is restricted to line-of-sight range, and consequently v.h.f. systems are often referred to as "short-range" equipment. High frequency (h.f.) equipment is carried by most aircraft for long-range communication. It covers a band of 3 to 30 Mc/s, with outputs up to 100 W, although equipments with larger powers have been used. The range is of the order of several thousand miles. The need for medium-frequency communication in airborne use has practically disappeared, but ultra high frequency (u.h.f.) is now already used in the military field, and it is likely to be developed for use in the civil field owing to congestion within the v.h.f. band.

Navigational Aids

Apart from the difficulties associated with the use of a magnetic compass owing to acceleration and altitude, etc., it is necessary for the aircraft compass system to provide reference signals to other equipments which require compass heading information. It is therefore necessary that compass information is amplified and capable of transmission as required. Modern aircraft are fitted with such a system which is normally duplicated and incorporates a low drift gyroscope monitored by the earth's magnetic field and therefore capable of the stable signal output required.

Barometric altimeters are limited in that they measure only barometric pressure and not true distance to the ground. This has encouraged the development of an electronic device capable of measuring the time required for the transmission of a signal to earth and its return to the aircraft, and resolving that into height above the ground. With modern systems this can be done with great accuracy at lower levels, but the accuracy falls off drastically above 5,000ft.

The automatic direction finding system, based upon

the directional qualities of a loop aerial, is probably one of the most widely used navigational equipments since it can be used in conjunction with normal broadcasting stations or with special beacons. Developed in recent years into a system which can be arranged to automatically home on a desired signal source, it can present the pilot with direct information of his position relative to a particular broadcast station and, with the addition of heading information to true north derived from the compass system, a precise geographical fix can be obtained. Considerable development has resulted in an equipment for aircraft use which has a static loop, the signals from which are resolved within the receiver.

Instrument landing systems, which are now universally used in large airports, necessitate special equipment in the aircraft to receive the necessary information in both pitch and azimuth, enabling the aircraft to home on a localiser and then descend towards the runway along a transmitted beam known as the "glide slope" to some predetermined break-off height. An instrument in front of the pilot displays, by means of two pointers, the aircraft's position relative to the centre of the runway, and its deflection from the glide slope beam.

Under instrument approach conditions using the equipment outlined above, there is a necessity for cross-reference to a number of information sources for the absolute safety of the aircraft and this has resulted in the development of flight director systems. These usually consist of two indicators arranged to give simultaneous indication of the aircraft's position in altitude and azimuth, compass heading, V.O.R. heading and steering details, the last being computed to give mean information without the necessity for over or under steer. Of necessity these systems are complex and a high degree of specialisation is required in both their development and integration into the aircraft.

The visual omni-range system (V.O.R.), which is widely used in the United States and is now being developed in other parts of the world, consists of a ground beacon transmitting signals which, when received by the aircraft equipment, can resolve the bearing of the particular station with relation to true north. The signals are coded to identify the ground beacon and the transmitted signals result in a number of radials, the bearing of which is shown on a special V.O.R. indicator.

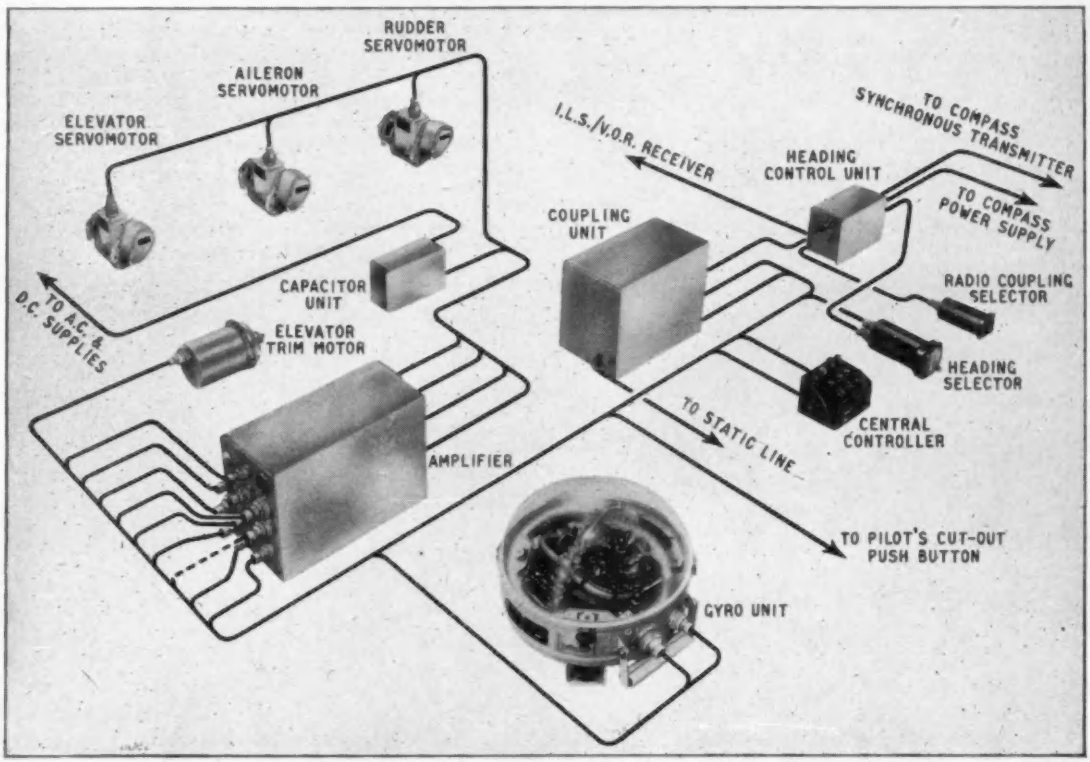
There are many other equipments which are in common use or may be used in the immediate future for navigational purposes, but space considerations permit reference to a few only. "Gee" is a navigational aid dependent on ground stations and operating over visual range. Fixes are obtained from special charts. A long-range version of Gee, "Loran," is used for trans-oceanic navigation, whilst "Shoran" is a short-wave aid developed in the United States. A beacon system for establishing aircraft distance from a given point is known as D.M.E. (distance measuring equipment), and the Decca system is a long-range aid dependent on ground stations and special charts.

Airborne weather radar systems operating in the "X" band (3 cm) or "C" band (6 cm) wavelengths are now increasingly being carried to detect storm centres. Mounted in the nose of the aircraft, they are usually stabilised and covered by a dielectric radome.

Control Systems

A large proportion of the auto-pilots in use are fully electrically operated, power being supplied to the aircraft control system directly and not through a hydraulic or

A schematic arrangement of a Smith's auto-pilot system



pneumatic auxiliary system. Apart from the acceptance of radio, altitude and compass information, all factors which may be added to the auto-pilot's control of the aircraft, the auto-pilot computer integrates signal demands rising from change of attitude, and provides an integrated response covering the aircraft's three axes.

The advent of jet engines has introduced the necessity for temperature control to prevent overheating, and a system is used which may either limit the upper temperature control or may constantly monitor the relationship between temperature and fuel. Temperature sensing is obtained from a ring of thermocouples situated in the engine or jet pipe, the output from which is amplified and fed to a control in the fuel system arranged to reduce or increase the fuel in accordance with pre-set engine temperature limits. Using similar methods, but substituting a Wheatstone bridge for the thermocouple system, temperature controls are also used in air-conditioning systems to maintain temperature comfort levels for passengers and crew. It is necessary to prevent such items as electrically de-iced windscreens overheating, and systems are used incorporating a sensing element within the glass, or other unit to be protected, forming part of a bridge circuit associated with an amplifier, the output of which may be fed to a cut-off contactor or a warning system. A combination of vibration pick-ups, amplifiers and indicators is used on some aircraft to detect any incipient out-of-balance of propellers or engines. Several systems are being developed and it is expected that they will be widely used in the future to prevent such major failures as the break-up of jet engine turbines.

Fuel contents gauging requires a considerable electronic system on a modern aircraft since it has become increasingly difficult to give indication of the fuel contents owing to the attitude and disposition of fuel tanks. A system in which special probes are fitted into the fuel tanks and the dielectric difference caused by the fuel, a quantity dependent on fuel level, is measured. To ensure accuracy it is usual for more than one probe to be used in a particular cell and the average value taken. This capacity measurement is compared to a signal equivalent to the "tanks full" value and the resultant out-of-balance is amplified and arranged to indicate at the pilot's dashboard. This system lends itself to the use of a totaliser enabling the aircraft's total fuel contents to be read at a glance. It is usual for fuel contents to be measured by weight rather than quantity owing to the effects of temperature, and compensation is sometimes included to allow for differences in specific gravity.

Conclusion

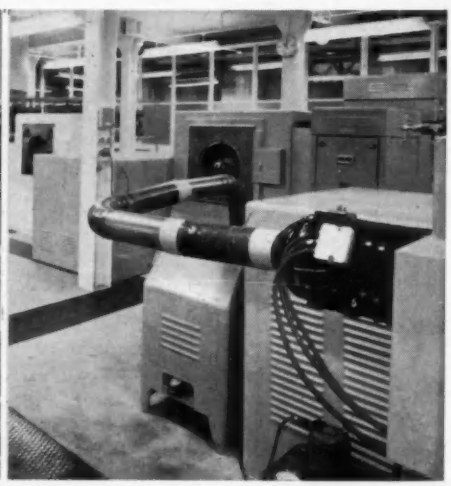
If the past progress is any indication of future growth, the application of electronic techniques to more and more aircraft control systems is assured. It can, however, be confidently predicted that the growth will not be linear and a vast stride will be taken, particularly in the field of automatic flight. It is not beyond the realms of possibility that the aircraft of the future may have a card plugged into an electronic computer which will then control all phases of flight from take-off to touch-down with the crew performing a monitoring function and only overriding the automatic system in an emergency.

LABORATORY FOR AIRCRAFT COMPONENTS

A NEW laboratory has been built by the British Thomson-Houston Co., Ltd., at Coventry for the development and testing of aircraft electrical power components and power systems. This laboratory will supplement existing facilities at both Coventry and Rugby. It has been designed particularly for the testing of constant-frequency power systems and is capable of handling a four-channel system with 60 kVA per channel at power factors of 0·75 and 0·8.

Four 100 kW motor-generator sets supply the four running stands, two of which have been specially designed for starter/alternator development. The motor-generator sets and the driving motors for each of the four running stands are controlled from ten consoles in the sound-proof control room. A load system is provided for each of the four channels. Air-cooled inductors are used for reactive loads while the resistive elements of the load are of the grid type with a low temperature coefficient.

Left: The control room in the new British Thomson-Houston aircraft power systems laboratory. Right: Alternator test sets. On the right-hand side an aircraft alternator is seen on test with air ducting attached



Three of the most important methods of reducing the risk of accidents in factories are considered by the author to be training and supervision of all who handle electrical equipment, efficient installation and maintenance programmes and, thirdly, the employment of only that plant which is of safe design

ELECTRICAL HAZARDS

ACCIDENT PREVENTION IN FACTORIES

By SIR HENRY CLAY, Bt., M.A., M.I.E.E.*

IN this article, the meaning of the word "hazard" is confined to "risk of accidents to people or danger to plant." The Oxford Dictionary does, however, give as one meaning "a game in which the chances are complicated by a number of arbitrary rules." There are times when one wonders whether the Electricity Regulations are not such rules. But these moments soon pass because, although the Regulations were made in 1908 and are specific in detail, they were quite remarkable in their foresight and do not, even now, often prohibit what might otherwise be safely done.

In general, the electrical inspectors interpret the Regulations as far as they can in the spirit rather than by the letter. If one may make a small criticism of that very fine body of engineers, the electrical inspectorate, sometimes an electrical inspector seems too ready to see the motes of imperfection in the new installations and overlook the beams of danger in the old works.

Electricity is used at voltages which can very easily be lethal and yet accidents are very rare. The reason, as was pointed out in the editorial on safety in a recent *I.E.E. Journal*, is largely because a number of conditions have to be coincident for an accident to happen. Most of these conditions are avoidable and, if at least one can be always avoided, freedom from accident is achieved. It is avoiding these conditions that is meant by the prevention of hazards.

In a single article it is not possible to cover the whole ground and certain hazards, such as those requiring flameproof or intrinsically safe equipment and the special requirements for welding, are not mentioned. Generally, emphasis is placed on what seems of most importance in reducing risk of accident and the ground to be covered can be conveniently split into three sections:—(1) Training and supervision of all who handle electrical equipment; (2) using plant of safe design; (3) installing and maintaining plant efficiently.

Each section is roughly of equal importance and is worth considering separately but the contribution each section can make to safety varies. Training is of greatest importance in avoiding shock and personal injury due to short circuit, whereas damage to plant is much more influenced by sound design and accidents from moving machinery by correct installation.

Training and Supervision

The attitude that, if an accident happens, it is *prima facie* evidence that plant or equipment is unsafe is one which factory inspectors tend to foster and is often encouraged by court decisions. It does, however, tend to make the worker feel that he need not bother and the less responsible managements that, as they will be censured anyhow, lip service is enough to training in safety. This attitude is wrong, because the greatest safety precaution of all is the worker's interest in knowing where danger lies and how to avoid it. The United States are ahead of us in their emphasis on the part the worker must play to ensure his own safety—"Safety depends on you; think before you act" is a typical slogan.

Training and supervision are difficult enough in big works where a full-time safety officer can be employed and occasional talks in working hours arranged, but in the medium-sized and small works it is much harder and requires the management to be personally interested and knowledgeable.

It must not be forgotten that to young people, particularly the more adventurous and go-ahead, the very word "safety" tends to be associated in their minds with the old and the over-cautious. It is not always easy for the young to differentiate between the adventurous and the foolhardy. The calculated risk taken with full understanding of the hazards involved rarely leads to an accident and accidents which can be avoided by training or supervision are nearly always due to ignorance or carelessness.

Procedure, laid down to avoid dangerous mistakes and invariably followed, is a very valuable adjunct to training and supervision, the most important part of such procedure being a permit-to-work system. Permits-to-work are widely used in large works with extensive high-voltage distribution but their value as a check that plant is safe to work on is such that a permit should be issued for work on any electrical equipment, irrespective of voltage. An exception should be made in the case of medium- or low-voltage plant where means of complete isolation is provided close by and in sight of the plant to be worked on, e.g. a local isolator for a motor and its starter, but not an isolator of down-shop crane tapes.

The permit should be made out, signed and countersigned, even if the man responsible for making the circuit dead and signing is the person wanting the permit-to-work. A page from a typical book of duplicate forms is shown in Fig. 1. The "clearance," which also requires signing and countersigning, is on the back.

Mistakes have been made, even where a permit has been issued, because the wrong plant has been made dead or because the wrong plant has been worked on, which emphasises the importance of clear labelling. On switchboards, a clear identification of each switch panel should appear on both the front and the back.

A permit system is just as necessary, but more often omitted or allowed to lapse, where work on electrically driven plant is being carried out. The danger is particularly great where starting is automatic or where parts

* Partner of McLellan & Partners, consulting engineers.

ELECTRICAL DEPT. 1605

PERMIT TO WORK ON ELECTRICAL PLANT

EXACT DESCRIPTION OF EQUIPMENT ON WHICH WORK IS TO BE DONE _____

DATE _____ TIME _____

THE ABOVE EQUIPMENT IS "ISOLATED" (* ALL IN-FEEDS HAVE BEEN LOCKED OFF)
(* AN EARTH HAS BEEN APPLIED AT _____)
THE FOLLOWING NOTICE HAS BEEN PLACED ON ALL SWITCHES SUPPLYING THE EQUIPMENT

DANGER
MAN WORKING ON THIS CIRCUIT
DO NOT CLOSE SWITCH

THE ABOVE EQUIPMENT WILL NOT BE MADE "ALIVE" UNTIL A CLEARANCE IS GIVEN.

SIGNED _____ AUTHORISED PERSON COUNTERSIGNED BY APPLICANT FOR PERMIT _____

* NOTE. CROSS OUT WORDS IN BRACKETS IF NOT APPLICABLE

Fig. 1.—A permit-to-work

of the plant are not visible from the control position. There was a fatal accident from this cause at a works where it was the practice at each meal break for men to go under rolling mill manipulators to remove scale. As this was done so frequently, the permit system had been allowed to lapse and one day an electrician took the opportunity to try out the drive, so crushing a man.

Using Plant of Safe Design

For most industrial applications, the available plant is safe provided it is properly applied, but bad choice or wrong installation often nullifies the manufacturer's good intentions.

Wherever possible, safety features should be inherent in the design of the plant, because in this way there is the least liability to failure and intentional circumvention of the safety features is most difficult. An obvious example of this type of plant is the substation switchboard where the circuit-breaker is connected through plug-in contacts and arranged so that it must be withdrawn before access can be obtained to any live parts on it. Another example of a simple design precaution not nearly widely enough used, is the provision of a low fault capacity, low voltage transformer-fed supply for control circuits on all but the simplest of control gear.

The following comments on design of plant rather than its installation deal with points not always fully appreciated.

Interlocking. This is provided for two main purposes: to prevent mal-operation and to ensure that access to plant is not available when unsafe. It is of two main types—mechanical and electrical—and very often both are used. Wherever possible interlocking should be inherent in the design and must be such that the plant can be operated and maintained, otherwise it will be circumvented or made inoperative. For instance, complicated control for a continuous process must almost certainly be tested while live and it is much better to provide open control boards, giving access to the equipment as free as possible from earthed metal and where possible using low voltage, than to provide enclosed panels with interlocked doors so that access is not available except when the board is dead.

Where the risk is serious and cannot be met by inherent interlocking, double interlocking, say mechanical and electrical, is often worth while and should, of course, be backed up with a permit-to-work.

Interlocking, using trapped keys, is valuable as a check that plant is being operated in the right sequence but it is often too easy to circumvent for it to be relied upon exclusively for safety. It has happened that duplicate keys have been supplied to a works by makers of quite independent plant.

Failure to Safety. That plant should fail to safety is a sound basis on which to work but very frequently it cannot be adopted, either because of the overriding importance of maintaining the supply whenever it is available or in complicated control schemes where it is impossible to achieve.

Even with such a simple safety device as a limit switch, it is often difficult to ensure failure to safety. Ideally, the moving part which is approaching a dangerous position should itself positively open the supply to the drive and the brake hold-off circuit, as in a direct-acting hoist limit switch, but often this is impossible and control circuit limit switches have to be used, operated by striking gear which may become detached. There are advantages in arranging limit switches so that they are brought into use in the normal operation of the plant, as this tests them frequently, but there is the disadvantage that they have much more use and may fail when the operator is relying on them. An overhead travelling crane has been driven right off the end of the rails with fatal results due to a failure of this type.

Earthing. Comments on earthing as part of the electrical installation are given later but it is a subject which is not always sufficiently taken into account in designing plant, particularly the earthing through the circuit-breaker of high-voltage plant. Earthing devices on circuit-breakers often give one the impression that they were added by the designer as an afterthought, being tiresome to install, the earthing bond frequently being too small to carry the fault current and having no proper point of attachment. In addition, a switch may sometimes be tripped by hand when it is in the earthed position.

Segregation of Circuits. Much more could be done in the design of gear to ensure segregation of circuits which may have to be worked on when others are alive; as an example, on medium-voltage air-break switchgear there are a number of designs where the busbars are not separated from the outgoing circuits nor are the outgoers separated from each other. The complete segregation of main and control circuits, particularly in conjunction with the use of low voltage, low fault capacity supplies for the control circuits, is undoubtedly a very valuable safety precaution.

Insulation of Conductors. The development of plastics, which can easily be moulded and have good electrical characteristics, has allowed conductors such as busbars to be covered throughout with insulation capable of withstanding the full voltage. This is a valuable feature contributing not only to reliability but also to safety. Not infrequently accidents occur due to electricians and others, who should know better, either coming into contact with high-voltage busbars by removing covers or causing short circuits on medium-voltage plant where fault capacities are high, possibly while trying to take measurements with a voltmeter.

Use of Low Voltage. The desirability of using a supply with a voltage to earth not exceeding about 55 V for

portable apparatus is now widely accepted. It allows a high standard of safety where the isolating transformers are part of the fixed installation and special plugs and sockets are provided for portable tools. Incidentally, where the centre point of the low-voltage supply is earthed, it is necessary to install fuse protection in both poles, a point sometimes overlooked.

Where a fixed installation is not available, it is more difficult to ensure safety. If a portable isolating transformer is used with the secondary winding, the core and the case earthed together, via the earthing pin of a normal 415/240 V three-pin plug and socket, the arrangement is very little safer than using a normal 240 V tool. There is, for instance, the danger of the earth lead becoming detached in the 240 V plug and touching the live lead, thus making the tool live. Fig. 2 shows an alternative suggestion for using a portable transformer, which appears safer but does not, in fact, comply with the Electricity Regulations.

One might query the validity of the assumption in Regulation 13 that, although there is no serious shock risk below 150 V on direct current, any alternating voltage may be dangerous. A well-designed transformer with an earth shield on high- and low-voltage windings, which are on separate limbs, may be considered safe from voltage break-through and the secondary voltage can be made low enough practically to eliminate the risk of shock.

Fire Protection. Much can be done in the design of plant to reduce fire risk, although there are many cases where it is more economical to use, say, oil-filled plant which has an intrinsic fire hazard and reduce the risk by siting and a fire-fighting installation.

A simple piece of apparatus which has prevented more than one transformer fire in the writer's own experience is the Buchholz relay, which is arranged to disconnect the transformer if an oil surge occurs. This relay must be fitted between the transformer and its conservator, but the comparatively small extra cost of the conservator appears to be more than justified in the practical certainty that it gives, in conjunction with an air-drying breather, of freedom from oil acidity.

Installing and Maintaining Plant Soundly

This is too big a subject to deal with other than by mentioning a few points which are not always understood.

Earthing. By far the greater part of industrial electrical installations comprise 415/240 V four-wire systems fed from star-connected secondaries of transformers, the neutral being earthed near the transformer at one point only. If all metalwork which might come into contact with phase voltage is connected with a sufficiently low impedance to earth, the risk of shock from metalwork not intended to be alive is eliminated and a large enough fault current will flow to operate the protective device concerned and cut off the supply.

It is of paramount importance that throughout an installation there should be a low impedance path back to the transformer. In most industrial plants there is no need for a low impedance to the main body of earth. This is frequently forgotten and money is spent to obtain a low earth resistance which would be better spent in achieving the lowest impedance to the transformer neutral. The exception is where a supply is given to isolated buildings, particularly by overhead lines without earth wires, but such an arrangement is not often sound practice in an industrial installation. For one large wartime factory, built on shallow gravel over rock, the factory inspector concerned agreed that there need be no attempt at providing an earthing system as such, as it would not add to the safety of the installation.

The easiest way to provide a low impedance return path to the transformer neutral is, of course, via the neutral line, that is by adopting a multiple-earthed system, and the writer considers that, in many cases, this is not only the cheapest but the safest arrangement. Where a works takes a high-voltage supply and has its own transformers, there is no reason why multiple earthing should not be adopted and this allows economy in lighting circuit wiring by using the concentric system and sheath return with mineral-insulated metalclad cable.

On systems where a supply between line and neutral is not required, there are many advantages in not earthing the neutral solidly, but merely having an indication of a failure to earth. Such a failure does not normally mean that plant has to be stopped. It can be taken out of service at the next opportunity. In addition, the damage caused by a failure of insulation is not aggravated by a heavy earth fault current. A common example is an insulation failure in a motor which can be simply and easily repaired whereas, with an earthed system, a rewind is often necessary. A difficulty with unearthed systems is to meet Factory Regulation No. 20 in an effective and reliable way. In many cases, the risk of danger because a system is charged at a higher voltage due, presumably, to an inter-winding transformer failure, is exceedingly remote. For instance, a 3,300 V system commonly used in large works to supply motors between, say, 100 and 1,000 h.p., is frequently run unearthed but it is all enclosed in metal which should ensure that the supply is cut off without danger in the event of an inter-winding failure.

On medium- and low-voltage plant which has to be worked on when live, safety can best be provided by avoiding earthed metalwork which may be touched at the same time as live equipment; guards should be of insulating material and, in addition, layout and guarding should be such that short circuits cannot easily be caused.

Explosion Risks. Plant containing oil, such as switchgear and transformers, is now usually provided with means of oil disposal, either by pebble-filled sumps or by piping the oil to pits. It is sometimes found that the sumps are water-filled so that, when the emergency occurs, they are unable to absorb the burning oil. Where oil is piped away to a pit, care is necessary that an

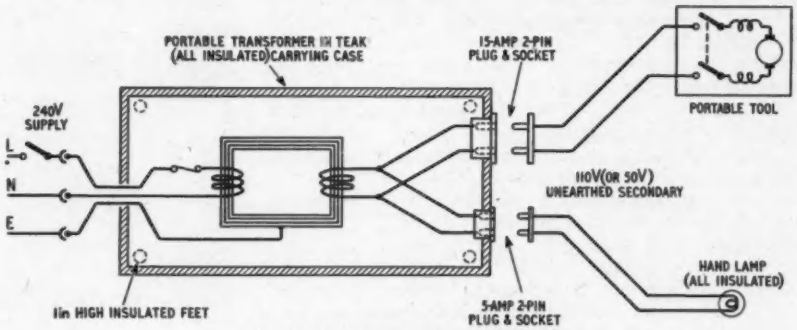
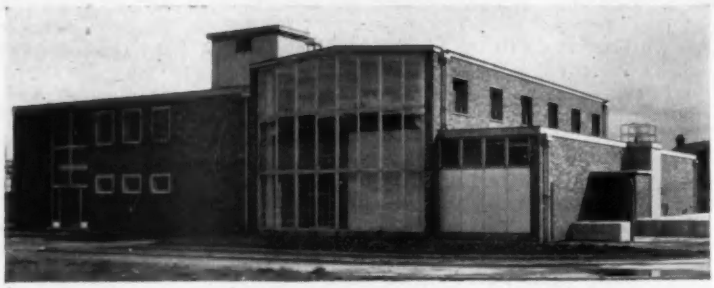


Fig. 2.—A safe portable transformer arrangement

explosive vapour cannot collect and be ignited by burning oil. Explosions from oil vapour can also occur in switch houses where venting circuit-breaker tanks to the outside air is often given insufficient attention. The buildings should be designed with the possibility of an explosion in mind. For instance, the roof or one wall should be of light construction which can blow out.

Plant Maintenance. The contribution that routine maintenance makes to safety is much more than ensuring that portable tools are tested and the integrity of earth-return paths in dangerous places is checked regularly. A properly planned system of maintenance not only ensures that all plant is inspected at pre-set intervals but also that plant is overhauled at such intervals as experience shows to be necessary. Tidiness is encouraged, so that, for instance, inflammable rubbish is not left in sub-stations or pieces of rag in transformer pens, where they may easily cause re-ignition of an oil fire. Incidentally, wide experience of such schemes makes it clear that they are the most economical way of looking after plant.



General view of the exterior of the new Metropolitan-Vickers irradiated materials laboratory at Wythenshawe

RESEARCH ON IRRADIATED MATERIALS BY METROPOLITAN-VICKERS

Nuclear Metals Laboratory

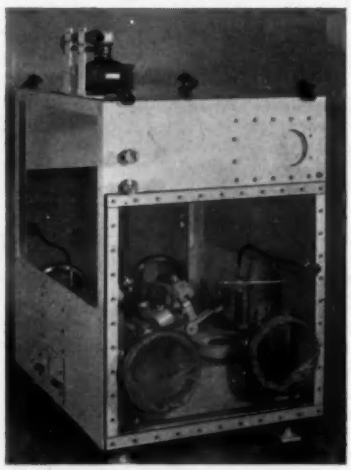
WHEN we visited the new irradiated materials laboratory of Metropolitan-Vickers at Wythenshawe last June research work was about to commence. It is planned to carry out metallurgical tests on specimens of various materials after exposure to irradiation in an experimental reactor and also to examine component parts withdrawn from power reactors after normal service. Examination and testing of materials ranging up to a complete fuel element having an activity of the order of 10 kilo-curies will be carried out.

The building has a total floor area of 8,000 sq ft and consists of a main laboratory, a small hot laboratory, a filter room, a health physics section, changing rooms and a decontamination room. The main laboratory has a floor area of 1,900 sq ft and is 21ft high. It contains two large concrete caves and a train of five interconnected lead-walled cells. The caves are used to receive large irradiated objects such as complete fuel elements and are constructed of barytes concrete blocks forming walls 3ft thick. The internal dimensions of each cave are 8ft by 6ft by 11ft high. Large doors are provided on one side of the caves, each weighing 25 tons and mounted on roller bearing skates. Special ports are fitted to allow radioactive fuel elements to be transferred from the massive lead coffins, in which they are transported, to the interior of the caves. These ports are closed by thick lead doors when not in use.

In the first cave, a heavy duty manipulator which can support 200 lb in any direction, will be installed as well as a diamond wheel cutting machine, driven by a 7½ h.p. motor, for slitting the fuel cans longitudinally. Both the heavy duty manipulator and the cutter are being made by Metropolitan-Vickers. The cutting operation is arranged to take place under water to prevent the spreading of radioactive dust and the machine also removes the can from the fuel element, cuts it up as required and cuts out sections from the fuel element itself.

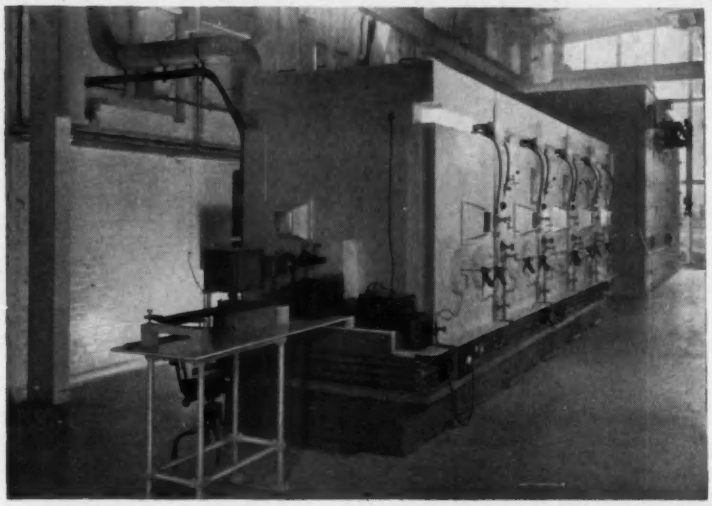
In the other cave, a left- and a right-hand Savage & Parsons remote control manipulator have been installed. Pye television cameras are mounted inside this cave and are connected to monitors which are within view of the manipulator operator. Here, specimens can be examined visually via the television circuit and their dimensions measured accurately before dissection. Mechanical testing can also be carried out.

When this preliminary examination has been completed, it may be necessary to conduct a metallographic examination on selected portions of the fuel element assemblies. This is carried out in the line of five lead-walled cells which are equipped to provide a complete remote controlled sequence. The cell walls are constructed of 6in thick lead slabs with a roof in the form of a removable concrete slab and ports arranged between the cells.



Inner container of one of the lead walled cells showing polishing apparatus

Each cell has an inner container constructed of steel and "Perspex." Lead-glass windows and spherically mounted handling tongs are provided on both faces of each cell and remote controls for



General view of the main laboratory with the caves in the right-hand background and the five metallographic examination cells in the centre. The remote controlled microscope and camera can be seen in the foreground on the end wall of the last cell

apparatus in the cells are brought through the walls where needed. A sample taken from the caves is transferred to the first cell in a small lead coffin. In this cell is an Oertling balance on which a specimen is weighed and its density determined. It is then mounted in cold setting resin by means of an automatic mounting device and is transferred to the next cell for rough polishing. In further cells it is attack-polished, electro-polished and anodised.

In the fifth or end cell is a variable-load hardness testing machine and a Reichert microscope modified for remote control and on which a full metallographic examination can be carried out. This microscope has all its controls on a panel outside the cell and the image formed by the microscope is also brought out through the walls of the cell to a camera. The optical system has two right-angle bends to obviate any direct paths for radiation from the interior of the cell.

The new laboratory will be primarily engaged on work for the A.E.I.-John Thompson Nuclear Energy Co. and on work under contract for the U.K.A.E.A. Irradiation examinations planned at present include certain aspects of the fuel element assemblies for Berkeley and an extensive examination of the effects of irradiation on zirconium alloys.

Electricity in the Irish Republic

THOUGH favourable to hydro-electric generation, the heavy rainfall during the summer and autumn of 1958 was not an unmixed blessing to the Electricity Supply Board of Ireland. Difficulties were experienced in harvesting peat with the result that, in the relatively dry period which followed, supplies were inadequate at a time when the inflow to the hydro stations was low, and greater use had to be made of imported coal and oil. Over the twelve months ended 31st March last about 65 per cent of the country's electricity output was obtained from native sources, rather less than in the previous year.

The installed capacity of the Board's stations at the end of the year was 688·5 MW (steam 469·5 MW; hydro 219 MW). New stations at Arigna (15 MW, coal fired), Lanesborough (20 MW, peat fired) and Clady (4 MW, hydro) were placed in commission and two further peat stations were under construction at Rhode (80 MW) and Bellacorick (40 MW).

Generating costs per kWh sent out in 1958-59 were as follows:—Peat-fired stations: Ferbane (milled peat), 1·033d; Portarlington (sod peat), 1·584d; Allenwood (sod peat), 1·909d; and four small stations on the west coast, 3·324d. Coal/oil-fired stations: Marina, 1·051d; Ringsend, 1·059d; and North Wall, 1·673d. Hydro: Ardnacrusha (Shannon), 0·267d; Cliff and Cathaleen's Fall (Erne), 0·413d; Pollaphuca, Golden Falls and Leixlip (Liffey), 0·618d; and Carrigadrohid and Inniscarra (Lee), 0·802d.

The rate of expansion in electricity sales further improved to 8·8 per cent from the previous year's 5·3 per cent and 3·5 per cent in 1956-57. New consumers numbered 20,576, making the total at the end of the year 590,921. Development has been largely in rural areas, where 14,997 additional consumers were connected. Grain dryers in sizes up to 15 kW were installed by 109 farmers and three larger installations, up to 50 kW, were also carried out.

The Board's gross revenue increased from £12·9 million to £13·8 million and working expenditure from £6·8 million to £6·9 million. After allowing for interest charges, etc., there was a net deficiency of £98,883 (against a loss of £194,583 in 1957-58) but this figure is subject to adjustments the effect of which is to leave a credit balance of £71,091. The average price received per kWh sold was slightly lower than in the previous year (2·14d against 2·17d). The merchandise trading account showed a profit of £16,921 and installations trading account £9,879; sales of appliances amounted to £752,524 (against £603,831) and consumers' installation work £401,288 (£367,042).

OUTPUT AND SALES

	1957-58 Million kWh	1958-59 Million kWh	Inc. or Dec., %
Generated and purchased	1,775	1,898	+ 6·9
Sent out:			
Hydro-electric stations	694	773	+11·4
Peat stations	489	385	−21·3
Coal/oil stations	509	652	+28·1
Sales:			
Domestic	611	679	+11·3
Lighting	87	90	+ 2·7
Heating, cooking, etc.	149	161	+ 8·1
Night storage heating	92	99	+ 7·4
Motive power	442	476	+ 7·6
Public lighting	31	32	+ 2·1
Traction and miscellaneous	12	12	—
TOTAL	1,425	1,549	+ 8·8

Referring to the rural electrification scheme, the Board's report points out that about five-sixths has now been completed and the remainder involves development in difficult, sparsely populated territory from which economic returns, even with the subsidy which was restored on 1st April, 1958, are unlikely to be obtained. Last year the deficiency on rural account was £656,000.

HIGH POWER SILICON RECTIFIER

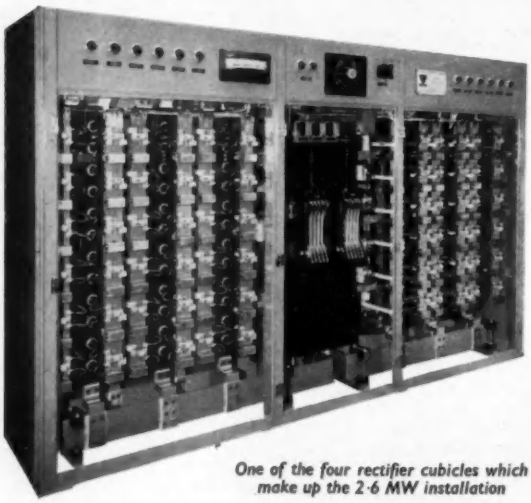
This 100 A silicon rectifier is capable of operating at 300 V (peak inverse) with a case temperature of 100 deg C

RESULTS of the considerable research and development work on semiconductors over the past few years are illustrated by the increasing number of devices such as transistors, diodes, photo-sensitive elements and rectifiers which are now available commercially. Many types of germanium and silicon power rectifiers exist, the last-mentioned having been specially developed to give small robust units capable of high outputs. A typical high power silicon rectifier is illustrated and this has a continuous rating of 100 A, a surge rating of 1,000 A, and it is capable of operating at a peak inverse voltage of 300 V with a case temperature of 100 deg C. Development work has reached the stage where it is now possible to employ these rectifiers in large numbers in high power a.c. to d.c. conversion equipments, giving installations of high electrical efficiency with economy in space.

A 2·6 MW silicon rectifier equipment has been made by Standard Telephones & Cables, Ltd., for installation at the Electrolytic Metals Corporation plant in South Africa, Transvaal, where it will be used in connection with the electrolytic production of manganese.

Apart from the a.c. circuit-breaker and the regulator which are mounted externally the whole equipment is accommodated in one room measuring 50ft by 20ft. This room contains the rectifier transformers, the silicon rectifier cubicles and their associated control cubicle, and the oil cooling system. A small control panel projects from this room through a dividing wall into the electrolytic plant area. Overhead busbars carry the 2,000 A load current at 130 V to the manganese cells.

A single 3·5 MVA regulator controls the entire equipment which is split into four transformer/rectifier sections arranged for parallel operation on the d.c. side. The equipment includes a.c. and d.c. isolators to allow one section to be taken out of service for maintenance while leaving the plant operating at 75 per cent full load. The total output current is maintained within 2 per cent of any required value between 15,000 and 20,000 A by a constant current control loop to the main input regulator, the necessary setting being made by the plant operator at the control panel in the electrolytic plant area. The regulator is also able to control the output down to 65 V at no-load.



One of the four rectifier cubicles which make up the 2·6 MW installation

Since the equipment is not in parallel with other conversion apparatus liable to give overload conditions there is no need for d.c. circuit-breaker protection. Fault current limitation is provided by the regulator and supply line reactors in conjunction with the reactances of the rectifier transformers. Normal d.c. overloads are likely from the electrolytic process, but protection against this is arranged by a.c. circuit-breaker tripping from current transformers in the a.c. isolator panel.

Each of the four rectifier cubicles contains two separate three-phase bridge connections of 100 A silicon rectifiers, supplied from a common a.c. busbar feeding via separate isolators into the main 20,000 A busbar. Six hollow aluminium busbars form the arms of each three-phase bridge and provide the cooling, by a circulatory oil system, to the 12 paralleled rectifiers in each arm. High-speed fuses are employed to protect each pair of rectifiers. The failure of one fuse in any arm is shown by an indicator lamp while the failure of more than one fuse in any one arm actuates an audible warning system.

The cooling oil from the oil busbars is circulated by a duplicate oil pump through an oil-to-water heat exchanger. The water is in turn circulated through a cooling spray pond. The overall operation of the cooling system maintains the oil temperature below 46 deg C, when 6,000 gal/hr of oil are cooled by 6,500 gal/hr of water at 30 deg C. Failure of the cooling system shuts down the equipment automatically.

The calculated efficiency of the rectifier is 98·2 per cent at full load while the overall equipment efficiency is 94·6 per cent. Even though the plant losses have been minimised by such techniques as using grain-oriented transformer cores, the rectifier losses contribute less than one-third of the total.

Fire Detectors

THE latest British Standard for heat sensitive detectors for automatic fire alarm systems in buildings, B.S. 3116 : 1959, specifies type tests for ensuring that the detectors will operate satisfactorily. One test measures the response time of a detector under conditions representative of the range of air temperatures and velocities occurring beneath the ceiling of an enclosure in which a fire is developing, and others deal with resistance to the effects of vibration and of corrosive influences after installation. Copies may be obtained from the British Standards Institution, Sales Branch, 2, Park Street, London, W.1, price 4s.

VIEWS on the NEWS

By REFLECTOR

COMMENTING on the Cambridge oxy-hydrogen fuel cell, the *Manchester Guardian* asks why power stations should "continue their profligate practice of burning 45,000,000 tons of coal a year simply to produce electricity which is energetically equivalent to 15,000,000 tons of coal or less!" There may be something in this unusual use of the adverb "energetically." The *Guardian* then goes on to mention the primary battery as a chemical method of producing electricity and very rightly says:—

> "But nobody would think of running the nation's electricity supply industry on the basis of flashlight batteries. For one thing they are far too bulky as pieces of capital equipment—kilowatt for kilowatt."

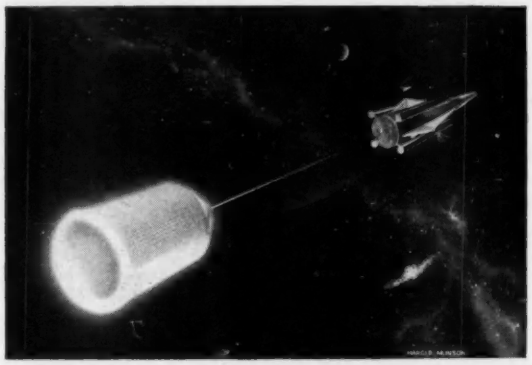
As producers of power on a large scale, the same might be said of fuel cells, I think, whatever reduction in size may be possible in the future.

* * *

Haydn wrote a "Farewell" symphony in which the members of the orchestra departed one by one until they had all gone. I was reminded of this somewhat by a demonstration staged by the G.E.C. last week to show the degree of perfection reached in sound recording and reproduction. The basis of the show was a "Sonata for Jazz Group with Tankards" composed by a member of the company's research staff, Mr. Eric Hughes, and recorded on tape in such a way as to enable the reproduction to alternate with the instrumentalists in a "five-piece" orchestra—piano, bass, clarinet, flute and cymbals. During the playing of the "sonata" the members of the orchestra (who were also members of the G.E.C. research staff) took turns at resting (with tankards) while the tape carried on. Two of the company's twin speakers were used for stereophonic reproduction and the instrumental passages were so adeptly taken up at each point that there was no noticeable hiatus or variation in quality of sound.

* * *

A novel method of converting nuclear power directly into electrical energy to run an ionically-propelled space vehicle through the gravity-free void of outer space has recently been proposed in the United States. This idea would appear to be somewhat fanciful but as it has been worked out by the Lockheed Missiles and Space Division in California it merits serious consideration. The vehicle and reactor would be projected into space by a large chemical rocket. As shown in the artist's impression of the arrangement which I reproduce, the vehicle is separated from the reactor by a mile-long coaxial cable to provide protection against radiation. The reactor, which would work at a temperature of 2,100 deg C, is designed to "boil" electrons off thermionic cells arranged around its outer shell, thereby producing electrical energy; this, transmitted through the cable, would provide the



power for the ionic propulsion system. The total power output of the 3½ ton reactor would be about 1 MW.

* * *

I have received a copy of "Electricity in Your Home" an illustrated booklet (published by Educational Productions, Ltd., East Ardsley, Wakefield, Yorks, price 2s 6d) which has just been revised. Upon the whole it is a useful guide to the use and maintenance of domestic electrical equipment and so far as I can see avoids the tendency of some such publications to suggest that the householder shall do too much in the way of electrical repairs. The publication offers some useful advice, especially when it recommends a regular inspection of switches, plugs, flexes, etc., at short intervals. The booklet is one of a series; the others are advertised in it and include one on gas which is claimed to explain how to use and maintain gas cookers, refrigerators and fires. I find it hard to believe, as is stated, that it has been "prepared with the Electrical Development Association."

* * *

Continental standards of wiring half a century ago were often rather low. How else could the tragedy reported in the *Electrical Review* of 27th August, 1909, have happened? It was said:—

> "Last week that portion of the world which takes an interest in matters electrical was startled to hear of the terrible accident which occurred at the village of Oliginate, a township of 2,000 inhabitants on the left bank of the Adda River, a few miles south of Lecco, Lombardy. It appears, from the numerous newspaper reports, that during a furious thunderstorm some high-tension transmission wires broke, and, in falling, came into contact with low-pressure distributors, with the result, apparently, that in numerous instances the wiring and switches in the houses started to fuse and burn up. The wiring, evidently of the surface type, fell about the rooms, catching the inmates in its coils, with disastrous results, as from this and from attempts to use switches, a dozen people were killed outright and about 30 received severe shocks and burns."

RADIO SHOW

TRENDS ILLUSTRATED BY THE EARLS COURT EXHIBITS

By E. A. W. Spreadbury*

TELEVISION, which last year lost pride of place at the National Radio Exhibition to stereophony, this year recovers its former eminence, the introduction of the 110 degree ultra-wide-angle cathode-ray tube giving television receivers an unmistakably "new look." This is calculated to titillate the man in the street, and still more the lady of the house, giving them a tangible advance in design that they can appreciate without any technical knowledge. Stereophony comes second; and radio, in the portable class of receiver, third, as a result of the virtual conquest of the valve by the transistor; while an upsurge of interest in tape recorders brings them into prominence. The Show, the 26th in the series, opened on 26th August at Earls Court, London, and closes on 5th September.

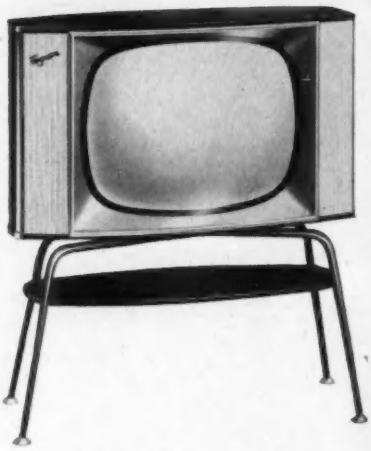
"Slim line" and "110 degrees" are key words on the exhibitors' stands, and the changes in cabinet design that lie behind them are remarkable. Table television sets have lost their bulk, enabling a 17in receiver to be housed in a cabinet of proportions more like those of a radio receiver, and portables look as though they can easily be carried.

Ingenious Cabinet Design

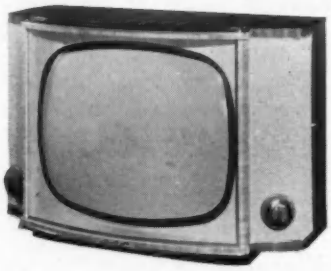
This is the direct effect of using a very wide-angled tube, whose overall length is several inches less than that of its 90 degree predecessor, but the facility thus provided has inspired cabinet designers to devise most ingenious methods of accentuating the effect. By pushing the tube well forward, for instance, and allowing the protective window in front of the tube screen to bow out forwards beyond the limits of the cabinet proper, the cabinet itself can be made to lose some of its depth. Then if the back cover, instead of being flat, is dished on the inside, its edges can be made to meet a still shallower cabinet. If the usual "blister" is then added to the centre of it to allow the rear end of the tube neck to extend a little way through the back cover, the depth of the cabinet can be reduced still further. Emphasis can be given to the effect by tapering the cabinet from front to back, giving its depth a diminishing appearance, and the result in some cases is really astonishing. One manufacturer, taking this idea to the extreme, tapers his set to a point, so that it can be hung in the corner of the room. A step nearer to the flat set that will hang on the wall.

One pleasing trend is to give the plan view a curved front contour, with the picture screen in the middle and a decorative panel on each side, and two examples of this form of styling are shown in the accompanying photographs. Usually the side panels are faced with fabric, and advantage is taken of the opportunity it provides to mount the loudspeaker behind it. Much more attention is given to the quality of sound reproduction today, and the speaker system may have two speaker units, for which this style of cabinet provides plenty of room. The tendency in better-class models is actually to use twin-speaker systems, one going in each panel.

The 110 degree tube has had a marked effect on port-



Novelties seen in this Ferguson consolette 21in television receiver include a swivelled mounting on the table, a shelf for programmes and a "new look" in cabinet styles



A new note in the rather stereotyped design of table television receivers is struck by the artistic styling of the new G.E.C. range. The curved line of the screen is continued to the corners

The legs of Murphy consolettes are ingeniously made to form a properly matched indoor aerial

* Technical Editor, *Wireless and Electrical Trader*.

able receivers, which have been made to look so slim that, despite their comparative lightness today, they are surprisingly heavy when they are lifted, because they look no bigger than a large attaché case. A specially short-necked variety of tube permits the overall depth of at least one 17in portable receiver to be got down to as little as 12in, while its actual case depth, neglecting the front and rear bulges, is about 6in. The first 21in portable model, and the only one known at the time of writing, is claimed to have a cabinet depth of only 11in.

One of the effects of the 110 degree tube is to render a 21in receiver more acceptable in small houses, where its bulk previously was obtrusive. There is, of course, still the need to sit far enough away from it to lose the effect of the lines of which the picture is composed, but about a third of the models shown have 21in tubes. Their prices, which began last year at about 85 guineas, now go down as low as 73 guineas.

To understand how the wide-angle tube saves cabinet depth it has to be realised that the overall length of the tube determines the depth of the cabinet, and the wider the angle of beam deflection, the shorter the (one time) bell-shaped front section can be. In an accompanying illustration a photograph of a short-necked 110 degree tube is seen superimposed on one of its immediate predecessors, a 90 degree tube, which shows clearly how much length is saved.

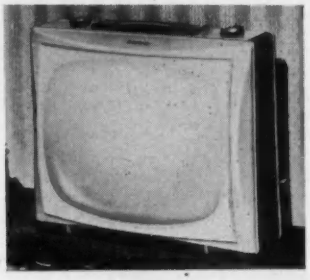
It might be thought that severe distortion of the trace must result from such a wide deflection angle, but this is compensated for in the scanning drive circuit. Likewise, focusing problems are greater, but they are taken care of in modern tubes by internal electrostatic means, and focus is maintained right into the corners of the picture. The greater scanning power that is necessary to deflect the beam is usually achieved by increased circuit efficiency, although this entails more critical operation.

Inclusion of F.M. Radio

A growing accompaniment to television in modern receivers is the inclusion of V.H.F., or F.M., radio programmes, to which television design lends itself readily, and this year 60 per cent of the models shown embody this facility. In the past its inclusion has not involved any considerable modification to the existing circuits, but complaints have been made of poor selectivity on the F.M. bands, owing to the rather high intermediate frequency (38·15 Mc/s) of television sound channels. This year that difficulty has been completely eradicated, but only at the cost of additional components in the receiver, and often by changing the I.F. on F.M. to 10·7 Mc/s. Yet the average extra cost for the F.M. facility this year is about four guineas, whereas last year it was five guineas.

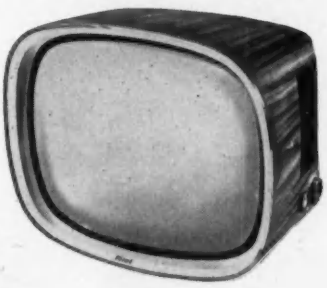
Printed circuits are used more widely than ever, but this year their principle has been extended to the printing of tuning coils for television receivers, which is quite an innovation, and several receivers now use them in their turret tuners. An example is shown in one of the accompanying illustrations, where one of the "biscuits" with its printed coils clearly visible on it, lies beside it.

A steadily rising objection to external television aerials is reflected in the spread of wired television systems, in which the signal is brought to the house by cable from a central receiving station which has a very efficient aerial system. This is particularly applicable to fringe areas, where an elaborate aerial is necessary, and in blocks of flats, because it usually ensures a better signal than can be obtained from an individual aerial system. In areas of high signal strength, however, the influence of portable receivers, which often use telescopic rod aerials, has led

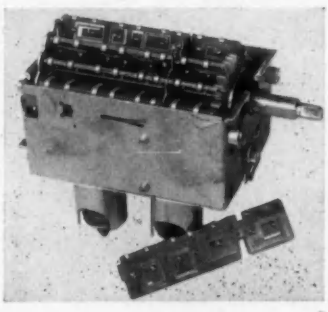


The slim line of the modern set with a 110 degree cathode ray tube is exemplified in the Ekco 17in portable. Its total depth is 12in, but its cabinet is only about 6in deep

The space-saving qualities of the 110 degree cathode ray tube are well demonstrated by this illustration, which shows the comparison between it and its "wide-angle" predecessor, the 90 degree tube. The 110 degree tube here is a special Ediswan Mazda short-necked variety measuring 11in from front to back



An excellent example of the "wrap-round" cabinet, almost fitting the tube screen, and the tapered rear "slim line" in table models, is provided by the Pilot 21in model

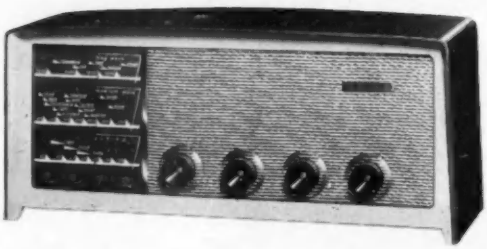


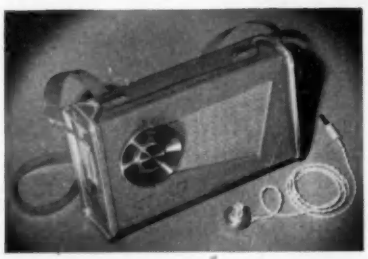
The Cyldon printed circuit tuner is seen here inverted with its screening cover removed, showing the "biscuits" in the turret drum. The printed circuit coils can be seen on the "biscuit" lying beside it

Most aerial manufacturers now make a "table-top" telescopic aerial to stand on top of the television set. The Belling-Lee model (right) has a tuning control to ensure a correct match. The Labgear "Satellite" (left) is designed to be decorative

A new class of receiver, the transistor table radio receiver, is represented by the Decca TP22 (left) and the Dansette (below), which are at the same time table and portable receivers. Previously transistor receivers have all been portables

Interesting new styling is being applied to break away from the humdrum pattern of table radio receivers. Here are the latest designs from G.E.C. (above) and Ferguson





Two examples of the very numerous transistor portable receivers, Perdio (left) and Emerson

to the widespread use of "table top" or "set top" aerials of the same type. Two examples of these are illustrated.

Except for refreshingly new ideas in cabinet styling there is little change in the pattern of the ubiquitous mains-operated radio receiver and a tendency to use multiple speaker systems, apart from the complete disappearance of console models. Most receive A.M. and F.M. transmissions, although a few low-priced A.M.-only models are shown, and for the more discriminating there are a few F.M.-only models.

Battery receivers, however, and especially portable models, are swinging over from valves to transistors, and most manufacturers show ranges of both types. Transistors have in the past not been readily available in quantity, and the general public have not understood the value of the new device, so that transistor receivers have not enjoyed the widespread popularity in the domestic field that they undoubtedly will in the future. It is difficult to believe that a small 6 V or 9 V dry battery of the flashlamp type can adequately replace the conventional 90 V h.t. battery, and that in addition no l.t. battery is required, yet the performance can be equally good.

It is possible to make a transistor portable receiver as small as a hearing aid, including battery, but at the time of writing none has been announced by any exhibitor at the Show. The reason is probably that larger loudspeakers provide better quality reproduction. Two of the smallest British transistor models are illustrated here. Most portables are now fitted with a car radio aerial socket.

Transistors can be used in table models, however, and at least three receivers of this type are shown this year, against one last year. In this form they challenge the valve in the mains receiver field; and they could succeed on the score of convenience alone, for no mains lead is then necessary. Their success depends very much on the quantity production of good high-frequency transistors, which at present are very scarce. In car radio receivers the transistor has taken over almost completely from the vibrator. Used in conjunction with a special type of valve that will work from a 12 V accumulator, transistors replace the output valve(s) only, and the vibrator is dispensed with.

Stereophony, somewhat hastily introduced at last year's Show, is likely to consolidate itself at this year's. Music lovers so far are in general unconvinced of its advantages, having been misled as to its purpose by an over-emphasis on railway train and ping-pong game demonstration records. An obstacle to its adoption, too, is the reluctance of the housewife to permit the installation of two pieces of equipment in her lounge, with very little latitude

in their siting. Then, again, few stereo records have been available.

Space consideration has led several manufacturers this year to produce "one-piece" stereo reproducers, with the two speakers at opposite ends of the same cabinet. Of two illustrations of this trend, one shows a flexible arrangement in which the end sections containing the two speaker systems (which may each contain two or three speaker units) can be separated from the central body, either permanently or when being played. In the other example, the overall width of the cabinet is greater, to separate the speaker systems as widely as possible. These two classes are supplemented by another in which the doors can be adjusted to act as deflectors, to spread the sound.

The advent of "stereo," with its need for two speaker systems, has stimulated the market for extension speakers, and a good variety of the better class of cabinet types is shown. Using modern acoustic chamber developments and multiple speaker units, high quality speakers with a very wide frequency range are available in comparatively small cabinets, often described as "bookcase" speakers because of their shallow depth.

The public demand for stereo can be confidently expected to increase as its real purpose is more widely appreciated, especially as the repertoire of special disc records is now more comprehensive (upwards of a thousand titles have been announced). Stereo has found its way into most of the radiograms at the Show, and at least one table radio receiver has a twin-channel stereo A.F. amplifier so that it can be used with a stereo pick-up. All stereo disc reproducers, of course, can be used to play ordinary "mono" records.

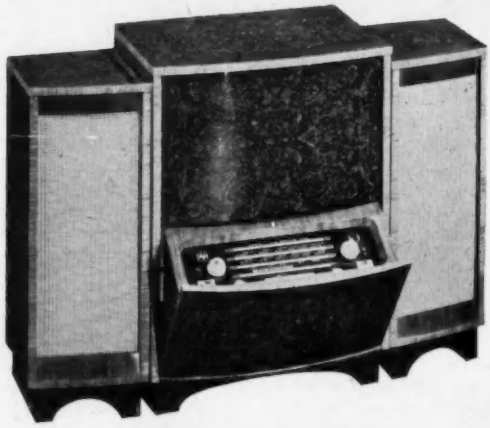
Tape Recorders

Stereo reproduction has been available for a long time on magnetic tape, but the greater simplicity of disc record operation has been necessary before stereo could be offered to the public. Yet in the meanwhile mono tape recorders (which, of course, are also tape reproducers) have grown in popularity, although this is due more to the simplicity of their recording facilities in domestic environments than anything else.

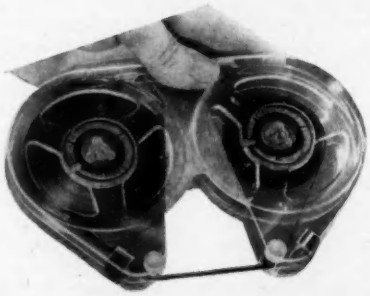
Their success as a domestic medium of musical entertainment depends upon the introduction of a tape loading device as simple to operate as are disc records. One such device was announced in America, but it has not come to fruition, and another is being tried. At the Show, however, what promises to meet this need is being introduced in the form of a cassette which holds the tape and drops into position on the deck in a single movement, automatically locking itself in position when the normal controls are operated.

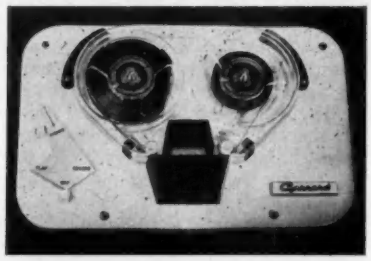
The growth of the popularity of the tape recorder is reflected in the large number of models offered this year. Prices are down drastically, several models being offered at 29 gns., while at least one can be had for 25 gns. It remains to be seen whether the buying public responds in the same measure.

This McMichael stereo radiogram is typical of the class that includes both speaker systems in the same cabinet

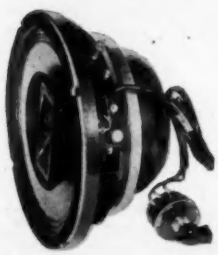


The two side sections in the H.M.V. "Meistersinger" stereo radiogram contains the two speaker systems, and they can be separated from the central section





An entirely new type of tape deck introduced at the Show by Garrard. The cassette of tape simply drops into place on the deck and locks in automatically



A new development in speaker movements is a three-system coaxial design. In this Goodmans "Triaxiette" can be seen the large cone, an intermediate horn, and in the centre an independent high-note speaker

ELECTRICITY AND FIRE RISKS

Misleading Deductions in Fire Research Publication

By D. J. BOLTON, M.Sc.(Eng.), M.I.E.E.

THE recently published report of the Fire Research Board which was reviewed in the *Electrical Review* of 21st August arrives at some surprising conclusions regarding the fire hazards associated with different forms of domestic heating. In an endeavour to rationalise the figures for fires due to electricity, statistics have been used which do not appear adequate to support the conclusions which have been based upon them.

One statistical exercise is an attempt to link the figures for fires of electrical origin with the consumption of electricity. Earlier reports had revealed that the annual incidence of these fires was increasing uniformly with electricity consumption, and the authors were rash enough to work out a rate, to wit one fire per 10 million kWh of electricity. (This refers to fires attributed to electrical apparatus which are of the order of 5,000 a year. The number of wire and cable fires, about 2,000 a year, do not appear to be rising.) However, during the last year recorded (September, 1957, to August, 1958) a special survey of these fires was carried out, and this time the formula broke down and the rate was approximately one fire per 15 million kWh of electricity instead of the expected one per 10 million.

Pattern of Electricity Consumption

Even without this regrettable misbehaviour it is difficult to see what good purpose can be served by attempting so broad a correlation. The cardinal fact about electricity consumption in this and most other countries is that it goes up every year in a persistently regular manner. A long-term increase in the neighbourhood of 7 per cent per annum superimposed on a short-term fluctuation dependent on the severity of the winter has been the pattern of electricity consumption for a very considerable period. It follows that anything whatsoever that is increasing steadily each year can be correlated with electricity consumption. If cancer is on the increase, if there are more deaths on the roads or more telephone calls are made each year, a relationship can be traced between each and all of these occurrences and the consumption of electricity. From this it is a short step to constructing a formula and forecasting the number of future occurrences from an extrapolated curve of electricity load growth.

A second example of tendentious statistics is described under the heading "Comparative fire hazard of various fuels." By combining the fire brigade figures for the number of fires attended in domestic premises with the Ministry of Power figures of fuel supplied for domestic consumption a coefficient is worked out of the fires attended per calorie of heat content of the fuel. This leads to the remarkable conclusion that the chance of starting a fire when using coal to produce a given quantity of heat is at present only about one-third of that when using kerosene to produce the same amount of heat. Apparently the authors' nerve failed them when it came to applying the coefficient to electrical risks but according to the figures given in the table the chance of starting a fire when using electricity would be, not three times (as with kerosene) but seven times that when using coal!

The report gives no indication of the method used in evaluating the heat equivalent of electricity when compared with raw fuel of the same thermal content, or in fact whether any adjustment has been made at all. Moreover, total domestic electricity consumption for all purposes has been compared with coal, gas and oil, with no allowance for the fact that the latter (unlike the former) would be used almost exclusively for heating and cooking purposes. But perhaps the largest of the many discrepancies underlying this method of comparison comes from neglecting the fact that a given thermal content of solid fuel might be consumed in a single piece of equipment whereas the same content of one of the other heating agents might be split among a dozen different equipments. Fire risks in equipment, in a word, are a function of the equipment, and to compare them on a basis of global heat consumption is to fog the issue.

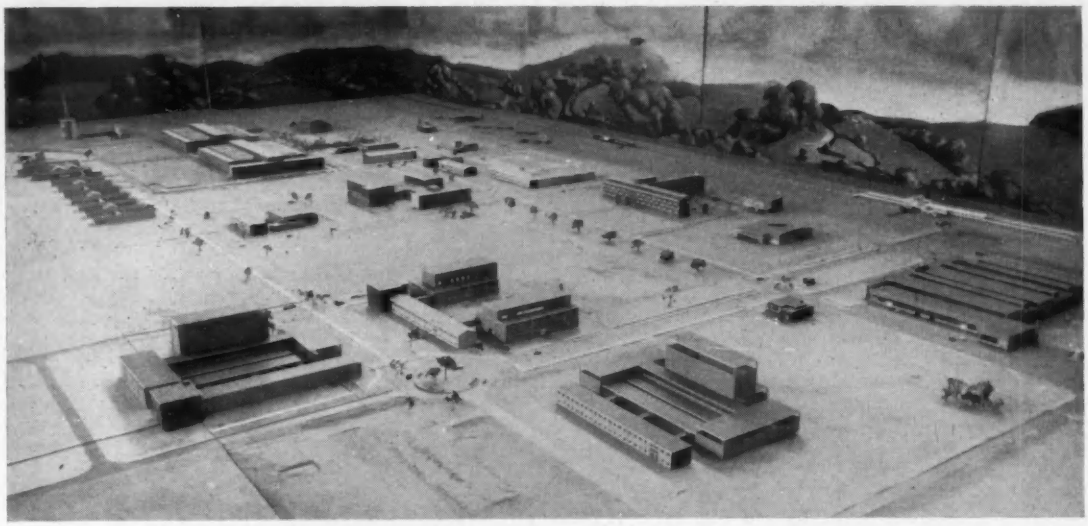
Ten-Year Forecast

The next step is the logical but very dangerous one of predicting how many fires of electrical origin there will be in ten years' time. Starting with the two known facts that electricity consumption is increasing and that the fires started are increasing, the assumption is that *therefore* the two are proportional. By extrapolating the graphs of domestic consumption of energy from different fuels the conclusion is reached that the annual incidence of fires in the home due to electricity may well increase by about 50 per cent in the next ten years while that of fires due to kerosene may about double.

Figures such as the above prove altogether too much—or nothing at all—and their most likely effect is to throw discredit on the whole statistical enterprise. This is unfortunate because a thorough statistical analysis of domestic fire risks could be of very real value and might well point the way to methods of reducing those risks. But it would need to be carried out with skill and with due regard for statistical disciplines in order to restrain it from chasing the first apparent correlation it came across.

O.L.M. REACTORS

AN organic liquid moderated and cooled reactor constructed by the Atomics International Division of North American Aviation, Inc., has operated successfully at thermal powers up to 11·2 MW. The experiment was initiated to study the characteristics of commercially available organic materials in reactor systems. One advantage of this system is that these liquids are relatively non-corrosive even under irradiation conditions but they have a tendency to polymerise when irradiated. However, if such substances could be used as moderators and coolants, a low capital cost reactor could be built using conventional materials for a lightly built pressure vessel with coolant outlet temperatures of 500 to 700 deg F. This experiment has shown that the hydrocarbon terphenyl is only slowly damaged by radiation and that its quality can be maintained by by-passing a small percentage of the coolant for purification by distillation.



Model of the Atomic Energy Establishment at Winfrith now under construction

Winfrith Atomic Energy Establishment

Two years ago construction work on the new Atomic Energy Establishment was started at Winfrith Heath. This work is now reaching an advanced stage and recently we had the opportunity of seeing what progress has been made

THE Atomic Energy Establishment which is in course of construction at Winfrith Heath, Dorset, is the second major Establishment of the Atomic Energy Authority's Research Group and is being built to meet the specific needs of a reactor research programme. The principle task is to initiate basic research and early development work on all aspects of atomic energy, and in particular provide new ideas and basic design data for application to power generation.

The Establishment is being built primarily for the physics and engineering development work necessary up to and including the reactor experiment or small prototype system. It will maintain a very close working relationship with Harwell, where the research and basic development work on the chemical, metallurgical and nuclear physics sides will still be concentrated.

At Winfrith the possible reactor sites are arranged around a central complex of buildings, the main ones of which are two zero energy halls, reactor group offices, a general services building, a central technical building and an apprentices' school. Other major buildings still to be erected are a health physics building, a medical centre, provision for control and instrumentation work, a building to house a "Mercury" digital computer and offices for the "Dragon" project.

Equipment already installed includes the PACE analogue computer which is being used for dynamic studies of the operational behaviour of possible reactor systems; the exponential experiment which has been set up for the high-temperature gas-cooled reactor programme, and ZENITH, the heated zero energy experiment which is also a part of that programme.

In a few months' time the team of physicists, mathematicians and engineers who are carrying out basic work in connection with the industrial nuclear power programme will move from Harwell to Winfrith. This team works closely with the Authority's Northern Groups, with the consortia who are undertaking the construction of nuclear power stations in this country, and with the generating boards who place orders for nuclear power stations. Staff from the consortia will work at Winfrith on the collaborative programme of long-range investigations known as the "Bicep" programme which is being moved from Harwell. This work is part of the joint programme for lowering the capital costs and improving the operating efficiency of gas-cooled graphite-moderated reactors.

Methods must also be developed for using as fuel the plutonium which will gradually become available from the burning of uranium in the earlier nuclear power stations. For this, new experimental installations will be built at Winfrith, such as hot contained exponential assemblies and a source reactor to drive them. The basic studies on gas-cooled systems will also need a further zero energy assembly, for which space is already available.

Another large area of work which will be moved to Winfrith when space permits is concerned with exploring the possibilities of reactor systems which might be suitable for use under lower load factor conditions than is the case with the present large base-load power stations, and with the longer-range possibilities of nuclear propulsion. Both of these projectives lead to a study of reactor systems moderated with light or heavy water instead of graphite. Basic and preliminary studies will

be carried out on boiling water reactors, and steam-cooled systems, and some basic work on organic liquid moderators will be continued.

The first reactor experiment to be built at Winfrith will be the "Dragon" project which was provided for under the agreement for a collaborative programme in the high-temperature gas-cooled reactor field signed in Paris last March by Belgium, France, Italy, Luxembourg, the Netherlands, Western Germany, Austria, Denmark, Norway, Sweden, Switzerland and the United Kingdom. The expenditure on this joint project over the five-year period from April, 1959, may amount to £13·6 million, and the countries have agreed that £10 million of this should be shared between them on an agreed basis, while any costs over this amount up to £3·6 million would be paid by the United Kingdom alone to whom any reactor experiment and other installation or equipment built or acquired in the United Kingdom would belong at the end of the five-year period.

The objectives of the joint project are two-fold, namely, to carry out a programme of research and development work on high-temperature gas-cooled reactor systems and design, construct and operate a reactor experiment embodying the results of this research and development work. The reactor experiment proposed in the joint project (ZENITH) employs cylindrical fuel elements consisting of an "impermeable" graphite can containing the fuel inserts. Helium is used to remove the heat from the core of the reactor as it flows under pressure past the fuel elements. In the heat exchanger the heat is removed from the hot gas (800 deg C) and rejected to the atmosphere, while the cool gas (350 deg C) is pumped by the circulating fans around the inside of the pressure vessel back to the reactor core to complete the circuit. As it is not yet possible to make a completely impermeable graphite can there is provision for an inward leakage of helium into the fuel element can which is then passed through a fission product trap and returned to the circuit. This keeps the activity of the main coolant circuit as small as possible.

London Wall Underground Car Park

THE Corporation of London's underground car park, which has been constructed beneath the first section (London Wall) of the new Route 11, is 426 yd long and can accommodate 250-300 cars. The charge is 7s per day.

The electrical services consist mainly of lighting and ventilation and a 37·5 kVA diesel/alternator has been included for emergency supply. The incoming supply feeds a busbar which supplies the main lighting, three 6 h.p. exhaust fans and the emergency services. The emergency services comprise lighting and three fans which are fed through a contactor in the diesel/alternator automatic starting controller. Under normal circumstances six ventilating fans will be operating together with the main and emergency lighting. On a power failure, the diesel/alternator set starts automatically and provides a supply for the emergency lighting and three ventilating fans. The Ruston Hornsby diesel engine drives a 37·5 kVA 400 V 50 c/s Dale alternator.

The main switchroom is located at the centre of the car park and there are two other switchrooms, one at each end. The supply for these switchrooms is carried in a large general services duct and cabling throughout is in Pyrotenax.

The surface street lighting equipment was supplied by the General Electric Co., Ltd., and consists of 22 special octagonal lanterns each containing four 80 W fluorescent tubes mounted on steel columns spaced at 78ft.

Surface street lighting by G.E.C.

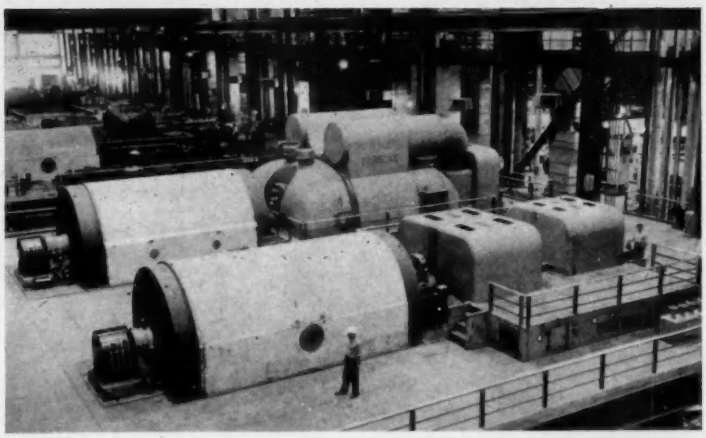
The main electrical contractors were the Universal Installations Co., Ltd. The fluorescent fittings were made and supplied by D. Walter & Co., Ltd., to the city engineer's requirements, the bulkhead fittings by Holophane, Ltd., and G.E.C., while Keith Blackman supplied the fans.

General view showing the fluorescent fittings

High-Temperature Strain Gauges

IN a paper published by the Institution of Mechanical Engineers, Mr. R. Bertodo (C. T. Bowring, Ltd., formerly with the De Havilland Engine Co.) described the development of a strain gauge for operating at temperatures up to 1,000 deg C with a predictable accuracy at any temperature within ±5 per cent. The gauge sensitivity factor was shown to be a function of the lattice imperfections of the element wire and to be temperature-conscious only if the imperfections themselves were affected by temperature variations. In general any factor that affects resistivity was found to affect sensitivity. The maximum current permissible to ensure less than 10 per cent of failures during a ten-hour life was 35 mA for 0·0016in diameter wires, 30 mA for 0·001in and 10 mA for 0·0005in. Wires having overall lengths of under 0·25in would probably be unsuitable for such gauges, but tests on colloidal suspensions in conjunction with pure alumina bonding material had been encouraging. Among many still unsolved problems, the most important concerned the means of attachment of lead wires.

GENERATION AND DEVELOPMENT



200 MW Parsons turbo-generator installed in the Richard L. Hearn power station, Toronto

Electricity Output in July

The Ministry of Power statistics of electricity supply last month show that the rate of advance was maintained at about the average for the first six months of this year, the increase, as compared with the corresponding month of 1958 being 5·8 per cent, and for the first seven months of this year 5·6 per cent.

The Electricity Council's analysis of Area Boards' sales gives the increase over July, 1958, as 6·8 per cent. When corrected for weather conditions and working days the rate of increase is stated to be equivalent to 9·9 per cent.

Separate figures supplied by the South of Scotland Electricity Board show that the total energy sent out was 342·7 million kWh, against 344·1 million in July, 1958. The net import from the C.E.G.B. was 54·6 million kWh and from the North of Scotland Electricity Board 5·9 million kWh. A total of 18·3 million kWh was taken from the U.K.A.E.A. Chapelcross nuclear station.

The North of Scotland Hydro-Electric Board in July sent out to its areas 105·5 million kWh, an increase of 11·7 per cent as compared with July, 1958, and the total for the first seven months of this year was 932·2 million kWh, an increase of 4·2 per cent as compared with the corresponding period of 1958. In the twelve months to 31st July last the total was 1,572·2 million kWh (against 1,510·5 million).

ELECTRICITY GENERATED AND SENT OUT FOR PUBLIC SUPPLY

	Fuel consumed Thousand tons			kWh generated Millions			kWh sent out Millions	Installed capacity (m.c.r.) MW
	Coal	Coke and Breeze	Oil	Steam	Water power	Total		
Central Electricity G.B. ...	2,731	81	314·0	6,490	2	6,496	6,082	26,182
North of Scotland H.E.B. ...	8	—	1·1	17	93	114	112	1,030
South of Scotland E.B.	189	3	0·2	354	11	365	343	1,651
Total for July, 1959	2,928	84	315·3	6,861	106	6,975*	6,537	28,863
Corres. total for July, 1958 ...	2,968	64	202·6	6,478	105	6,593	6,184	26,989
Inc. or dec., per cent	−1·4	+31·6	+55·7	+5·9	+0·9	+5·8	+5·7	+6·9
Total to date (7 months), 1959...	26,186	689	2,317·5	58,883	1,159	60,120	56,569	
Total for corres. 7 months of 1958	26,995	580	1,063·2	55,623	1,203	56,922	53,545	
Inc. or dec. per cent	−3·0	+18·7	+118·0	+5·9	−3·7	+5·6	+5·6	

* The total figure includes generation by other methods amounting to 8 million kWh.

ELECTRICITY SENT OUT BY BOARDS FOR THEIR CONSUMERS

Board	Totals for July (million kWh)			Twelve Months Totals Ended 31st July (million kWh)		
	1958	1959	Inc. or Dec. %	1958–9	1959–60	Inc. or Dec. %
London	448·9	458·0	+ 2·0	7,557·3	7,876·8	+ 4·2
South Eastern	330·9	343·2	+ 3·7	5,030·9	5,384·5	+ 7·0
Southern	416·5	447·1	+ 7·3	6,333·6	6,979·1	+10·2
South Western	220·9	230·9	+ 4·5	3,080·4	3,302·8	+ 7·2
Eastern	522·6	549·8	+ 5·2	8,036·1	8,527·1	+ 6·1
East Midlands*	471·3	499·6	+ 6·0	6,701·8	7,109·4	+ 6·1
Midlands*	591·3	636·6	+ 7·7	8,674·6	9,277·6	+ 7·0
South Wales*	368·1	414·7	+12·7	4,970·9	5,229·9	+ 5·2
Merseyside and North Wales* ...	388·0	410·5	+ 5·8	5,255·9	5,519·9	+ 5·0
Yorkshire*	598·0	641·7	+ 7·3	8,630·2	8,853·7	+ 2·6
North Eastern*	355·8	378·5	+ 6·4	5,040·8	5,214·8	+ 3·5
North Western*	606·2	635·6	+ 4·8	8,918·1	9,145·5	+ 2·5
Total all Area Boards	5,318·5	5,646·2	+ 6·2	78,230·6	82,421·1	+ 5·4
Direct Supplies by C.E.G.B. ...	241·4	293·0	+21·4	2,781·4	3,200·8	+15·1
Grand Total	5,559·9	5,939·2	+ 6·8	81,012·0	85,621·9	+ 5·7
Mainly Industrial Areas*	3,378·7	3,617·2	+ 7·1	48,192·3	50,350·8	+ 4·5
Mainly Non-Industrial Areas ...	1,939·8	2,029·0	+ 4·6	30,038·3	32,070·3	+ 6·8
South of Scotland E.B.	386·3	421·6	+ 9·1	6,495·3	6,904·2	+ 6·3
North of Scotland H.E.B. ...	94·4	105·5	+11·7	1,510·6	1,572·2	+ 4·1

* Those in which industrial consumers took over 50% of the total sales in the preceding financial year.

Large Turbo-Generator Installed at Toronto

The 200 MW Parsons turbo-generator at the Richard L. Hearn generating station, Toronto, is the largest turbo-generator yet installed in the Commonwealth. This machine, now in service, is the first of four 200 MW machines ordered from Parsons by the Hydro-Electric Power Commission of Ontario for installation in the Hearn station. The installation of these units will bring the station capacity to 1,200 MW.

The turbo-generator installed is of the cross compound design, one line consisting of a h.p. and i.p. turbine driving a 100 MW hydrogen cooled generator at 3,600 r.p.m. The other line comprises a second i.p. turbine and l.p. turbine driving a 100 MW hydrogen cooled generator at 1,800 r.p.m. The operating steam conditions are 1,800 lb/sq in at the stop valve, 1,000 deg F temperature with reheating of the steam between the h.p. and first i.p. turbines to a temperature of 1,000 deg F. The 60 c/s hydrogen-cooled generators operate at 13,800 V and 0·85 p.f.

Canadian Grid System

The Atlantic Provinces Economic Council, Halifax, announces that the power systems of the Nova Scotia Light & Power Co., the New Brunswick Light & Power Commission, the Nova Scotia Power Commission and Canada Electric, Ltd., are to be interconnected by a 138 kV grid. The first stage is a 60-mile line being built by the Nova Scotia Light & Power Company which will have the largest transformer ever installed in the Maritime Provinces and will connect a total generating capacity of more than 500 MW.

INDUSTRIAL NEWS

Contracts for "Nimrod"

The National Institute for Research in Nuclear Science announces that contracts amounting to a total cost of over £430,000 have been placed for the manufacture of the magnet coils required to energise the 7,000-ton electromagnet of the 7,000 million electron-volt proton synchrotron. This machine, which has been named "Nimrod," is being built for the Institute by the United Kingdom Atomic Energy Authority at the Rutherford High Energy Laboratory, Harwell. Contracts have been awarded to British Copper Refiners, Ltd., Prescot, Lancs., for the supply of over 300 tons of refined copper (from which the coils are to be made), in the form of cast billets; to James Booth & Co., Ltd., Birmingham, for extrusion of the cast copper into hollow rectangular bars; and to the Metropolitan-Vickers Electrical Co., Ltd., Manchester, for the manufacture of the finished coils from the extruded bars. The Institute has also awarded a substantial contract to Marston Excelsior, Ltd., Wolverhampton, for the development and supply of the reinforced plastic vacuum chamber in which the protons are accelerated.

Switchgear Production

Although switchgear manufacture can hardly be regarded as a rural industry, in the accepted sense, the works of J. G. Statter & Co., Ltd., at Amersham, Bucks., have a truly rural setting. We recently had an opportunity of visiting the works under the guidance of the chairman of the company, Col. Marston, D.S.O., M.C., M.I.E.E., who is also chairman of the Lancashire Dynamo Group, of which Statters is a part.

The main products of the works are isolator switches and oil and air circuit-breakers for operation at up to 600 V and 8,000 A; and 11 kV automatic oil-immersed circuit-breakers, fuses and switches for indoor and outdoor applications. The gear is made up into switchboards which are supplied largely for industrial undertakings. A substantial proportion of the equipment produced is exported and Statter gear is in service in most countries.

Practically the whole of the production processes are carried out in the works. At the main factory there is a non-ferrous metal foundry which produces a wide range of castings in brass, gunmetal, bronze and aluminium. The newer No. 2 factory is equipped for steel fabrication and the welding of cubicles, frames and tanks for the main works. Extensions are in hand which will greatly add to the floor space and efficiency of production.

Our inspection also covered Minerva Mouldings, Ltd., a subsidiary company which produces compression mouldings in a number of plastics for a variety of purposes, including parts for switchgear, domestic appliances and power tools.

Microwave Radio Link

A microwave radio system some 524 miles long, having a total capacity of 600 two-way telephone circuits, one unidirectional television channel and one two-way telephone and television stand-by channel, has recently been commissioned between St. John's, Newfoundland, and Sydney, Nova Scotia. The system was supplied by Standard Telephones & Cables, Ltd., to the order of the Canadian National Telegraph Co.

Reinforced Epoxide Pipes

The reconstruction of drainage systems at Battersea generating station has involved the use of some 1,000ft of reinforced epoxide pipes carrying effluent from flue-gas washing plant to a treatment unit from which it is discharged into the Thames. The effluent contains a percentage of sulphuric acid and, owing to a slight ash content, is highly abrasive. All the new pipes, manhole covers and fittings were made from bakelite epoxide resins reinforced with glass fibre and terylene, the latter giving added abrasion resistance to the inner surface of the pipes. The pipework was manufactured and installed by Mendip (Chemical Engineering), Ltd.

Assembly shop at the Amersham works of J. G. Statter & Co., Ltd.

American Aid for European Nuclear Stations

The Euratom Commission and the Washington Export-Import Bank recently signed agreements implementing a $135 million (about £48 million sterling) line of credit from the Bank to help finance European power plants under the United States-Euratom joint programme. The goal is a total installed generating capacity of about 1,000 MW to be achieved in 1964-65. The total cost of the plants is estimated at $350 million (about £125 million sterling); the balance in addition to the Bank's loan will be raised from European sources.

The agreement also provides for a co-operative nuclear research and development programme to be carried out simultaneously by Euratom and the United States.

"Overhead Line Charts"

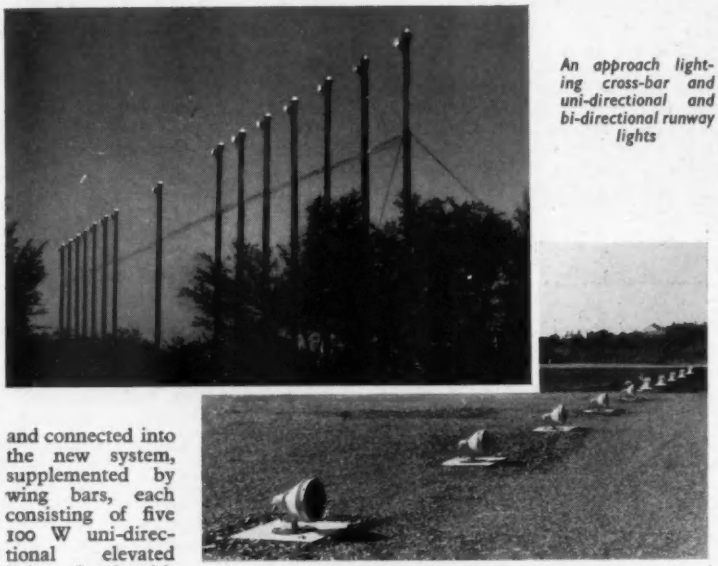
A Government Department wishes to acquire copies of Dr. J. S. Forrest's "Overhead Line Charts," which is now out of print. We should be glad to pass on any spare copies which readers may be able to provide.

Jersey Airport Lighting

A new airfield lighting system supplied by the General Electric Co., Ltd., has been installed at Jersey Airport by C. Maurice Contractors, Ltd. The runway, which is being extended by 550ft to 5,000ft, is provided with high-intensity elevated runway lights, employing an optical system having a one-piece pressed heat-resisting glass refractor designed for use with the 6·6 A 200 W tubular Osram lamp. The lens is in the form of a dome embodying two prismatic panels positioned to give two high-intensity beams elevated 3 deg above the horizontal and converging 3 deg towards the runway centre-line.

Spaced at 200ft intervals along each side of the runway, the lights provide a maximum beam intensity in both directions of 35,000 candelas and an omni-directional component averaging 2,000 candelas.

At the west end of the runway, where an extra 100ft is available for take-off only, the ten existing 100 W threshold lights have been retained



An approach lighting cross-bar and uni-directional and bi-directional runway lights

and connected into the new system, supplemented by wing bars, each consisting of five 100 W uni-directional elevated lights fitted with green colour filters. At the eastern end the threshold lights are similar to those used on the runway but equipped with green colour filters, again supplemented by two wing bars of 100 W uni-directional lights. The runway and threshold lights can be controlled in five steps of brightness down to 1 per cent.

With the extension of the runway the whole of the eastern approach system has been moved outwards. The centre-line has been extended to 3,000ft and an additional cross-bar provided at a distance of 2,000ft from the threshold.

The new taxiways, and the outer limits of the apron, will be marked with flush taxiway lights.

All lighting is selected from a console in the control tower, from which a 50 V d.c. control cable runs to the switchroom housing G.E.C. contactor cubicles and main series circuit transformers.

Head, Wrightson Brochure

We have received from Head, Wrightson & Co., Ltd., a brochure which reviews in picture form (some in colour) the activities of its group of companies. The text is in English, French, German and Spanish. Reference is made to the heat exchangers which the company is erecting at Bradwell nuclear power station.

Railway Signalling Equipment Order

The contract recently awarded to the Siemens & General Electric Railway Signal Co., Ltd., by British Railways' Eastern Region for signalling equipment on the L.T.S.-Tilbury Loop covers the portion of the line from Rippleside (Barking) to Tilbury Riverside and Stanford-le-Hope. The contract involves the provision of 112, three and four aspect searchlight signals, some two aspect colour light signals and about 80 combined point machines and covers 23 miles of track. Track circuits are mainly d.c. operated. There are about 300 in number but there are also a few a.c. track circuits at 83⅓ c/s.

New L.T.E. Laboratory

Work has begun at Chiswick on a two-storey building to house the Central Laboratory of London Transport's Research Department. The new premises will have a floor area of 26,000 sq ft and will give space for additional staff and for improved new apparatus. Among the facilities to be provided are a cold chamber for low temperature testing, a specially-designed, screened room for work with a 200 kV industrial X-ray apparatus and for gamma-radiography using a cobalt 60 source, heat-treatment furnaces and welding equipment, a pilot plant laboratory, special recording equipment for strain gauge tests, and a fatigue testing machine for railway car axles—the only one of its kind in Great Britain. The small laboratories at London Transport's three generating stations will be retained for local requirements.

Creep Information Centre

A centre to collect and tabulate all the available data on the creep and rupture properties of conventional high-temperature materials is being set up by the Department of Scientific and Industrial Research at the National Engineering Laboratory at East Kilbride, Glasgow. A leaflet giving further details of the scope of the Creep Information Centre is available from the Laboratory.

Stage Lighting

An illustrated booklet, "Practical Small Stage Lighting," by E. E. Faraday, price 4s, has been published by W. J. Furse & Co., Ltd., Traffic Street, Nottingham. It gives a simple explanation of the practical ways of using various items of lighting equipment available for small stages and covers such subjects as "emphasis" lighting, the use of magazine type battens, footlights and spotlights, and the use and choice of colour. Control equipment is also dealt with, and the booklet concludes with some useful hints for those in charge of small stage lighting installations.

Vibratory Feeders for Dutch Coal Mines

The Magnetic Equipment Co., Ltd., has received an order for the Dutch Coal Mines for the supply of forty-four of its 400 tons/hr vibratory feeders, type SVF4, handling a wide range of coal from very fine dust to medium lumps, all units being employed in conjunction with an automatic weighing equipment for the mixing of coal in the specified grades according to the ash content. The order was obtained with the co-operation of the company's German associates, Dr. Ing. Carl Kuttner of Essen.

Crompton Parkinson Hebburn Depot

A new Contract Department depot has been opened by Crompton Parkinson, Ltd., in High Lane Row, Hebburn, Co. Durham. Mr. G. W. G. Cutting, of the Crompton Parkinson Newcastle branch office, will be responsible for the operation of the new depot which comprises three floors of approximately 13,000 sq ft each floor, plus a

The steam condenser tubes of a naval destroyer being inspected by Sperry "Introview" equipment. The operator is shown using the compressed air gun to propel the "Introview" probe down a condenser tube. The probe is then drawn back through the tube by the winch unit shown in the centre foreground and a recording is made of the state of the condenser tube

considerable uncovered storage area. Although primarily intended to serve the cable installation requirements of work on the 20 kV system on Tyneside, undertaken for the North Eastern Electricity Board in the area, the new depot will provide service for local industrial concerns and two contracts in this category are the re-cabling at the Parsons Marine Turbine Co.'s works at Wallsend and the cabling contract for the Bede Jetty being built by Vickers-Armstrong (Shipbuilders), Ltd., at their Palmers Yard, Hebburn.

Contract Price Formulæ

The British Electrical and Allied Manufacturers' Association has issued the figures for its contract price adjustment formulæ. In each case the rate of pay for adult male labour at 21st August is deemed to be 196s. The "costs of materials" figures are: For electrical machinery and equipment the Board of Trade index figure published on 21st August is 177·9 (1949=100) and 114·7 (1954=100); both figures are provisional. For turbo-generating and allied plant: Materials used in mechanical engineering industries 185·5 (1949=100) and 123·5 (1954=100); both figures are provisional. Blast furnaces and iron and steel melting and rolling (40 and 41) 188·7 (1949=100) and other steel goods, excluding tubes (311 and 312), 130·0 (1954=100). The price of ¾in o/d 18 s.w.g. brass condenser tubes (*Metal Bulletin*, 21st August) is 48d per lb.

I.E.E. Summer Meeting

In our report of the recent meeting of the Institution of Electrical Engineers in the North Midland Centre we regret that we omitted to mention the visit paid to the Leeds works of the Yorkshire Switchgear & Engineering Co., Ltd., after members had had lunch as the guests of the company. Founded in 1907, the present site occupies 17 acres and although not finally developed the factory represents a medium capacity plant employing 400 personnel. The company are pioneers of outdoor metalclad switchgear construction, their principal products comprising a complete range of metalclad oil circuit-breaker and oil-switch equipments for distribution and heavy industrial service up to 500 MVA at 22 kV. A prototype 33 kV 750 MVA metalclad unit was also demonstrated.

Stockholm Trade Fair

At the St. Eriks Fair, Stockholm, which will be held from 2nd to 13th September, a large number of British companies are taking part in the consumer goods and capital goods sections. The exhibits will include a large animated model of a complete nuclear power station.

Equipment for Swedish Broadcasting

Marconi's Wireless Telegraph Co., Ltd., has been awarded a further contract for the supply and installation of television and sound broadcasting equipment by the Royal Board of Swedish Telecommunications, which has planned a major expansion of Sweden's television and f.m. sound broadcasting networks. The contract is valued at approximately £292,000.

Nuclear Propulsion of Ships

The English Electric Co., Ltd., has announced the completion of a preliminary survey of possible reactor systems for the economic nuclear propulsion of merchant ships. This study project has been carried out by a group of English Electric reactor engineers advised by marine engineers from Vickers-Armstrongs, Ltd.

Radio Towers

A demonstration of radio tower equipment recently given by Access Equipment, Ltd., included the erection of a 130ft aluminium triangular tower. This consisted of eighteen 7ft sections hoisted manually with the aid of a special davit, forming part of the tower kit. A five-man team is capable of erecting such a tower in about four hours after the base has been prepared. Elaborate footings are unnecessary.

At the Yorkshire Switchgear luncheon (left to right): Mrs. S. E. Goodall, Mr. S. E. Goodall, president, Mr. G. S. C. Lucas, vice-president, Mrs. W. E. Turner, Sir Hamish MacLaren, vice-president, Mr. G. Caton, managing director, Yorkshire Switchgear, Mr. W. K. Brasher, I.E.E. secretary, and Mrs. Brasher

Electrical Engineers Exhibition

The 9th Electrical Engineers Exhibition sponsored by the Association of Supervising Electrical Engineers will be held at Earls Court, London, from 5th to 9th April next. The 1960 feature will be "Marine Electrics." Bookings for stand space will close early in September.

Rocket Research Cables

Multi-core irradiated polythene cables for use at the new Rocket Research Establishment at Spadeadam were the subject of a short note under this title in the issue of *Electrical Review* dated 12th June. Since publication, further information has been received, stating that cables of this type were also supplied for this project by Mersey Cable Works, Ltd.

Oil-Filled Cable for Hunterston

Pirelli-General Cable Works, Ltd., has been awarded a contract by the South of Scotland Electricity Board for the manufacture and installation of some 19,500 yards of 132 kV single-core oil-filled cable for Hunterston generating station. The insulation of this cable is designed for 110 kV/cm maximum working stress.

Trade and Technical Literature Competition

The Building Centre announces that in view of the delays resulting from the recent printing dispute the organisers of the Manufacturers' Trade and Technical Literature Competition, 1959, have decided to put back the last day for receiving entries until 31st December next.

G.E.C. Manipulator Orders

The General Electric Co., Ltd., has received three further orders, valued at £40,000, for heavy-duty power-operated manipulators for the remote handling of irradiated nuclear-reactor fuel elements. One is for the Japan Atomic Energy Research Institute at Tokai-Mura, one for A.B. Atomenergi, the Swedish Atomic Energy Co., to be installed at the Studsvik Research Station, and the third for the Atomic Energy Research Establishment at Harwell.

Mine Winder for N.C.B.

An order for a 1,750 h.p. mine winder has been received by the Mining Division of the English Electric Co., Ltd., from the National Coal Board. The equipment will be installed at Newstead Colliery in No. 4 (Alfreton) Area of the East Midlands Division. The new winding arrangements consist of a conventional double drum winder, having a payload of

seven tons, with a capacity of 400 tons per hour from the High Main level at a depth of 750ft. The 1,750 h.p. d.c. motor is fed from a 3-phase, 50 c/s, 11,000 V supply via 1,085 kW 750 V convertor equipment. Robey & Co., Ltd., of Lincoln, are the sub-contractors for the mechanical equipment.

Australian Telecommunications Link

With its Australian associates the Electric Construction Co., Ltd., Wolverhampton, has secured contracts valued at nearly £200,000 for the telecommunications power equipment for the Sydney to Melbourne coaxial telecommunications link from the Australian Posts and Telegraphs Department.

The contract covers no-break power plant sets, standby diesel alternator sets, and control cubicles for all power supplies.

Plant for Mauritius

A fifth repeat order for diesel generating plant for the St. Louis power station has been received by Mirrlees, Bickerton & Day, Ltd., Stockport, a member of the Hawker Siddeley Group, from the Central Electricity Board of Mauritius. The equipment to be supplied comprises a Mirrlees KVSS 12 cylinder engine rated at 2,947 b.h.p. at 428 r.p.m. direct coupled to a Brush alternator giving an output of 2,103 kW and is the sixth such set to be supplied by Mirrlees.

Large De-aerators

A de-aerator, believed to be the largest in the world, is being designed and built by William Boby & Co., Ltd., for the feed heating system associated with the 550 MW Parsons turbo-alternator set at Thorpe Marsh power station, near Doncaster. The turbo-alternator is nearly 100 yd long and the de-aerator plant occupies some 36,000 cu ft, being about 80ft long, 15ft wide and 30ft high. The company is also supplying two large de-aerators for the feed heating systems of the two 275 MW English Electric sets to be installed at Blyth "B" power station in Northumberland.

Colliery Signalling Systems

The North Western Division of the N.C.B. has ordered two sets of the "Wigan" type 40 shaft signalling indicator made by Heyes & Co., Ltd., for installation at the new Agecroft Colliery, near Manchester.

A.E.I.-Hotpoint District Office Fire

The A.E.I.-Hotpoint district office and showrooms were completely gutted in a fire which occurred in Newcastle on 17th August. Alternative premises were found on the following day at 9, Higham Place, Newcastle-upon-Tyne, 1 (telephone: Newcastle 21008). All orders which had been received from the trade up to last weekend had been transmitted to the central distribution depot at Northallerton and deliveries as usual are being made direct from there to Hotpoint's dealers. Vans have been switched to supplement the transport facilities in order to ensure that no dislocations occur. In addition, lorries were immediately loaded with spare parts at the Peterborough factory in readiness for moving into the new base. The only orders lost were those posted to the Newcastle office on 14th and 15th August, and dealers are asked to duplicate these.

The A.E.I.-Hotpoint district office and showrooms at Newcastle during the fire which gutted the building

Sulzer Brothers' 125th Year

Sulzer Brothers, Ltd., celebrate this year the 125th anniversary of the foundation of the company.

Price Reductions

A.E.I.-Hotpoint, Ltd., announces substantial reductions in prices of its type CJ and CK automatic immersion heaters from 1st August. Prices of type CD automatic immersion heaters and of Twimersers remain unchanged. Minor adjustments to prices of flanges and fittings are being made and will be included in revised price lists now in preparation.

List prices of certain Siemens Ediswan fluorescent tubes have been reduced. The new prices for lamps in standard colours and exclusive of purchase tax will be as follows: 125 W 8ft MCFC/U switch start or instant start, 17s 6d; 125 W 8ft MCFCR/U (reflector) switch start or instant start, 20s; 6 W 9in and 8 W 12in MCF/U switch start, 7s 6d.

Revised list prices are announced for G.E.C. germanium function transistors and point-contact diodes. Existing list prices have been reduced, and other devices have list prices quoted for the first time. Included in the new price list is the S1 audio frequency transistor which has the same general characteristics as the GET114 but carries a 6 V rating.

The London Engineers Pattern Co., Ltd., has reduced the prices of its trefoil cable clamps.

Trade Announcements

Isopad, Ltd., has appointed Mr. M. R. Parker as application engineer for the London postal district. Mr. C. E. Tandy, who used to cover the whole of the Southern Area, will concentrate on the other Home Counties and the South of England. The technical representative for the Midlands is Mr. J. H. Habgood, also operating from headquarters; Mr. R. V. Arnfield, 20, Clarendon Road, Sale, Cheshire (telephone: Sale 9591), is the technical representative for Lancashire and Yorkshire. McCulloch & Miller, 180 West Regent Street, Glasgow, C.2 (telephone: City 4704/5), represent Isopad in Scotland and Luke Martyn & Co., Ltd., 17, Adelaide Street, Belfast, in Northern and Southern Ireland.

During the first week of September the London office of the **D.P. Battery Co., Ltd.,** is moving to 137, Victoria Street, London, S.W.1. The telephone number and telegraphic address will remain unaltered.

Mr. R. A. Duller has been appointed a lighting division representative in the South-East Region of **Philips Electrical, Ltd.** He will cover the south-east postal districts of London.

M.T.E. Control Gear, Ltd., has concluded an exclusive agency and distributorship agreement with Vanrow Engineering (Pty.), Ltd., Denver, Johannesburg. In the early stages of the agreement Vanrow Engineering will import unassembled parts from which it will build control panels and standard starters for the Union of South Africa and associated territories. The agreement provides for complete manufacture of M.T.E. products under licence at a later date.

Texas Instruments, Ltd., is to erect a new plant at Mantons Lane, Bedford, which will ultimately have a manufacturing area of 100,000 sq ft.

The **Claremont Electrical Distributing Co., Ltd.,** is opening a branch on 1st September at 68, Oxford Street, Southampton (telephone: Southampton 24159), which will be trading under the name of **Southampton Electrical Distributors, Ltd.** The branch will be under the supervision of Mr. J. Herbert.

Mr. G. E. Jones has been appointed sales engineer for **Sharp Control Gear, Ltd.,** for the Midlands area. For the past three years Mr. Jones has been on the sales staff of Contactor Switchgear, Ltd.

PERSONAL AND SOCIAL

News of Men and Women of the Industry

Mr. F. H. S. Brown, C.B.E., B.Sc., M.I.Mech.E., M.I.E.E., has been appointed deputy chairman of the Central Electricity Generating Board in succession to **Mr. C. R. King,** C.B.E., whose appointment as chairman of the Electricity Council with effect from 1st September was recently announced. Mr. Brown has been a full-time member of the Board since its formation two years ago, having previously been chief engineer of the Central Electricity Authority. He was educated at King Edward School, Birmingham, and Birmingham University, and after service with the Birmingham and Liverpool Electricity Supply Departments became generation engineer (construction) and subsequently chief generation engineer of the British Electricity Authority's Merseyside and North Wales Division.

Mr. F. H. S. Brown

Mr. G. A. S. Nairn, M.B.E., F.R.S.A., of Bromborough, Cheshire, has been reappointed as a part-time member of the C.E.G.B.

Mr. G. C. Dale, B.Sc., has been appointed physicist deputy in the Nuclear Health and Safety Department of the C.E.G.B. After gaining his degree at University College, London, Mr. Dale spent a short period in industry before joining the Radiology Section of the National Physical Laboratory at Teddington in 1946. He entered the Ministry of Supply in 1949 and joined the department which subsequently became the Health Physics Division of the Atomic Weapons Research Establishment, Aldermaston.

The British Transport Commission announces that **Mr. J. H. Fraser,** O.B.E., B.Sc., A.M.I.C.E., M.I.R.S.E., chief signal engineer of the British Railways Central Staff at the Commission's headquarters, will retire on 12th September. He will be succeeded by **Mr. A. W. Woodbridge,** O.B.E., M.Sc., M.I.E.E., M.I.R.S.E., signal engineer, Western Region, British Railways.

Mr. M. Robinson, who has been associated with Lancashire Dynamo since 1946, has been appointed manager of the group's Bristol area office with effect from 1st August, in succession to Mr. E. N. Evans, M.I.E.E., M.Amer.I.E.E., who has taken up an appointment with another company. At a lunch held recently in Bristol at which the company's representatives were guests, Mr. D. C. Lorkin, managing director, Lancashire Dynamo Group, welcomed Mr. Robinson to his new appointment and made a presentation to Mr. Evans on behalf of the company directors and staff.

Radiation (Large Cooking Equipment), Ltd., will in future handle all the business formerly done by Radiation Group Sales, Ltd., Large Apparatus Division, and by the Jackson heavy duty section of the Electrical Division of Radiation, Ltd. **Mr. A. O. Russell** will be general sales manager, **Mr. A. V. Cooper** becomes sales manager, gas and steam apparatus, and **Mr. H. K. Tomkins,** formerly sales manager of the Jackson Electric Stove Co., Ltd., heavy duty division, is appointed sales manager, electrical apparatus. **Mr. D. A. Shortis** is senior technical officer, Southern England, and **Mr. J. G. Stride,** senior technical officer, Northern England. The head office of Radiation (Large Cooking Equipment), Ltd., is at 255, North Circular Road, Neasden, London, N.W.10, but until further notice the Sales Department will be at Radiation House, 7, Stratford Place, London, W.1.

Mr. F. P. Bishop, M.B.E., M.P., chairman of Morphy-Richards, Ltd., sailed in the *Athlone Castle* on 20th August for South Africa. He will visit the Morphy-Richards subsidiary, Morphy-Richards (Pty.), Ltd., at Johannesburg. On his return journey by air he will have discussions with Morphy-Richards agents in Salisbury, (S. Rhodesia), Nairobi (Kenya) and Athens (Greece).

Mr. G. B. Durham and **Mr. R. A. Hall** have been appointed regional engineers to the British Lighting Council for the areas covered by the London and Eastern Electricity Boards and the North Eastern Electricity Board respectively. Mr. Durham's office is at 16-18, Lancaster Place, London, W.C.2 (telephone: Temple Bar 7337), and Mr. Hall is at Northgate House, St. Mary's Place East, Newcastle-upon-Tyne, 1 (telephone: Newcastle-upon-Tyne 21245).

Mr. G. B. Durham

Mr. R. A. Hall

After leaving Oxford, Mr. Durham served in the Army before entering the lighting industry in 1952. Mr. Hall has been in the industry since 1946, before which he served in the Navy. He has been with the English Electric Co., Ltd., on production control, Ekco-Ensign, Ltd., in its Preston illuminating engineering office, and the General Electric Co. in Newcastle.

The following appointments were made when the A.E.I. district offices took over from the offices of the British Thomson-Houston Co., Ltd., the Metropolitan-Vickers Electrical Co., Ltd., and Ferguson Pailin, Ltd., last month:—

A.E.I. Home District Office Executive.—General manager, Mr. W. A. Ankerson; district office executive (Manchester), Mr. R. S. D. Bagnall; and district office executive (Rugby), Mr. K. G. Leach.

Regional Managers.—Scottish, Mr. L. Whitham; North Western, Mr. A. C. Ellis; Northern, Mr. A. J. Crawford; North Midlands, Mr. W. J. Wilson; Midlands, Mr. K. J. Clarke; South Western, Mr. J. S. Hall; and Southern, Mr. E. Mead.

Mr. W. A. Ankerson, B.Sc.(Eng.), A.M.I.E.E., who is also deputy managing director of A.E.I. Overseas, Ltd., after technical training at Northampton Polytechnic became a college apprentice at M-V in 1932. After working as a motor design engineer, he went to the Shanghai office of the M-V Export Co. as an assistant technical sales engineer in 1936. In 1938 he became manager of the Shanghai office but later he and his family were forced to go to Hong Kong and in 1942 he joined the Australian General Electric, Pty. (now Australian Electrical Industries Pty., Ltd.), as chief industrial motor design engineer; he went back to Hong Kong in 1946 as manager of M-V's China office. In 1949 Mr. Ankerson returned to London as manager of the M-V Export Co.'s Dominions Division and in 1953 was appointed assistant to the chairman of A.E.I., becoming a deputy managing director of A.E.I. Overseas, Ltd., in 1955.

Mr. R. S. D. Bagnall, D.F.H., M.I.E.E., M.Am.I.E.E., went to M-V as a college apprentice in 1933 and in 1938 joined the Bombay office of A.E.I. (India). From 1941 he was with the Admiralty, first in Ceylon and subsequently at Bath. After the war he joined the Brush Electrical Engineering Co., being London office manager from 1947 to 1952, and later becoming a member of the local board of directors at Loughborough. He

became manager of the M-V Sheffield office in 1954.

Mr. K. G. Leach, M.A., A.M.I.C.E., A.M.I.E.E., joined the B.T.H. Co. as a student apprentice during vacations while at Emmanuel College, Cambridge, where he passed the Mechanical Science Tripos with honours. He served during the last war as an electrical officer in the R.N.V.R., and later (in 1949) was appointed a power engineer in the London District office; in 1952 he became manager of the Bristol office. In 1954 Mr. Leach was appointed assistant to the chairman of A.E.I. and in 1957 became responsible for district office matters with the B.T.H., Rugby.

Mr. L. Whitham joined Metropolitan-Vickers in 1920. After serving at the Glasgow district office, in Edinburgh and on the east coast, he took over industrial sales at Glasgow. He was appointed assistant manager, Glasgow office, in 1946, and district office manager in 1948.

Mr. A. C. Ellis, Associate I.E.E., was apprenticed to Metropolitan-Vickers in 1920, and he also attended the Manchester College of Technology. He was attached for many years to the company's Manchester office and in 1952 was appointed district office manager at Cardiff. In 1956 he returned to Manchester as district manager, a position he held until his present appointment.

Mr. A. J. Crawford received his technical education at the Manchester College of Technology and joined Metropolitan-Vickers as a school apprentice in 1912. After serving in the first world war, he spent periods in various commercial departments at Trafford Park, and in 1925 was attached to the company's Glasgow office as sales engineer. In 1946 he transferred to Newcastle-upon-Tyne as assistant district manager, and became district manager in 1947.

Mr. W. J. Wilson, A.M.I.E.E., was educated at Acton and Chiswick Polytechnic and Acton Technical College before apprenticeship at the B.T.H. Willesden Works. He was eventually at the Sheffield and Manchester offices, and was appointed assistant manager, Leeds District, in 1954 and manager in 1955, and manager, Sheffield District, in 1958.

Mr. K. J. Clarke, A.M.I.E.E., entered M-V from Coventry Technical College. After completing an engineering apprenticeship at the B.T.H. Coventry Works in 1931, he was appointed to the Industrial Machines Department at Rugby. In 1936 he was posted to the B.T.H. Birmingham office but during the war returned to Coventry for special duties. He rejoined the Birmingham district office in 1944 and in 1953 went to the B.T.H. Sheffield office where, following a term as assistant manager, he became manager in 1957. He was appointed manager of the B.T.H. Birmingham district office in 1958.

Mr. J. S. Hall, Associate I.E.E., received his technical education at the Manchester College of Technology and in 1921 joined Metropolitan-Vickers as an apprentice. In 1925 he supervised the erection of equipment in Russia for Babcock & Wilcox, Ltd. He joined the Meter Sales Department at Manchester in 1926 and two years later went to the Cardiff office. In 1937 he joined the Bristol sub-office and in 1948 became manager of the Swansea sub-office. In 1952 he was appointed assistant manager of the Manchester office, and in 1956 manager of the Cardiff office.

Mr. E. Mead, B.Sc.(Eng.), M.I.E.E., after training at Brighton Technical College joined Metropolitan-Vickers as a college apprentice in 1925. From 1926 to 1933 he specialised in heavy switchgear, spending a short time with Manchester Electricity Department. In 1933 he became manager of the Stoke-on-Trent sub-office and in 1944 transferred to London where he has been actively concerned with the electricity supply authorities. He was appointed assistant manager, London office, in 1952 and manager in 1953.

Four new appointments are announced by the A.E.I. Heavy Plant Division. **Mr. E. C. Barwick,** B.Sc.(Eng.), M.I.E.E., has been appointed manager, Large Electrical Machine Engineering (Rugby), **Mr. E. E. A. Grace,** B.Sc.(Eng.), A.M.I.E.E., manager of the Medium Electrical Machine Sales, **Mr. K. F. Raby,** M.A.(Cantab.), A.M.I.E.E., manager, Medium Electrical Machine Engineering, and **Mr. W. H. Hunt** becomes superintendent, Medium Electrical Machines Department.

Mr. Barwick joined the British Thomson-Houston Co., Ltd., in 1932 and served a student apprenticeship until 1935 when he transferred to the A.C. Engineering Department, which later became the Plant Engineering Department. In March last year he was appointed assistant manager of the department to supervise large machine design. In his new appointment he takes charge of the design of all large a.c. and d.c. machines (with the exception of turbo-type alternators) built in the Rugby Works.

Mr. Grace and Mr. Raby are concerned respectively with the sales and design of motors and generators manufactured at the Rugby Works for general industrial applications falling within the scope of the A.E.I. Heavy Plant Division. Their appointments are made as a result of the creation of new departments to deal specifically with this class of equipment.

Mr. Grace joined the B.T.H. Co. in 1940 and on completion of an engineering apprenticeship in 1944, transferred to Plant Contracts which, on the formation of the A.E.I. Heavy Plant Division, became Large Electrical Machine Sales; he has been section leader of the hydro-electric section since 1954.

Mr. Raby joined the B.T.H. Co. at Rugby in 1946 and two years later became a design engineer in the Plant Engineering Department, becoming section engineer in 1951. He was appointed assistant manager of the Department in 1951, in charge of medium machines.

Mr. Hunt was a B.T.H. apprentice. After holding various positions with the company he became general foreman of the motor factory machine shop in 1947, assistant superintendent of the motor factory in 1953 and superintendent in 1956.

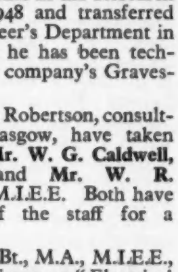
In order to give **Mr. J. Bowthorpe** more time to attend to the affairs of Bowthorpe Holdings, Ltd., he has resigned from the position of managing director of Hellermann,Ltd., and **Mr. R. A. Parsons** has been appointed managing director. Mr. Parsons joined the company when it was formed in 1938 and for many years has been assistant managing director. Mr. Bowthorpe will be chairman of Hellermann, Ltd.

Mr. R. A. Parsons

Mr. O. S. Johnson, B.Sc., A.M.I.E.E., has been appointed to take charge of the High Tension Section of the Research Laboratories of W. T. Henley's Telegraph Works Co., Ltd. He succeeds **Mr. B. F. Salvage,** B.Sc., Ph.D., A.M.I.E.E., who is taking up an appointment as lecturer at Leeds University. Mr. Johnson joined Henley's as a chemist in the Research Laboratories in 1948 and transferred to the Chief Engineer's Department in 1951. Since 1956 he has been technical officer at the company's Gravesend Works.

Messrs. Strain & Robertson, consulting engineers, Glasgow, have taken into partnership **Mr. W. G. Caldwell,** A.M.I.Mech.E., and **Mr. W. R. Murray,** B.Sc., A.M.I.E.E. Both have been members of the staff for a number of years.

Sir Henry Clay, Bt., M.A., M.I.E.E., who writes in this issue on "Electrical Hazards" (page 115), was educated at Gresham School, Holt, and was awarded a Mechanical Sciences Tripos from Trinity College, Cambridge. He served his apprenticeship with the British Thomson-Houston Co., Ltd., and from 1933 to 1937 was employed as assistant engineer with the company. From 1937 to 1942 he was assistant engineer with McLellan & Partners, later became technical director, and since 1954 he has been a partner.



Sir Henry Clay

Mr. K. G. Sillar, M.I.E.E., A.M.I.C.E., northern regional con-

troller for the Board of Trade, is to retire. Mr. Sillar had a long experience in industry before entering Government service. After the 1918 war he joined the Metropolitan-Vickers Electrical Co., Ltd., becoming manager in Western India in 1930. From 1931 to 1940 he was sales manager and assistant general manager for the Calcutta Electric Supply Corporation.

Mr. E. E. Rant, Belfast district manager for Hoover, Ltd., has retired after thirty years' service and has been succeeded by **Mr. P. H. Chivers,** hitherto an area manager in the Cardiff district.

In the annual report of Oldham & Son, Ltd., the retirement is announced of **Mr. S. J. Wrigglesworth,** O.B.E., deputy managing director. Mr. Wrigglesworth joined the company thirty-nine years ago, serving as general manager for twenty-six years and for the past two years as deputy managing director. **Mr. Orlando Oldham,** M.A. (Cantab.), son of Mr. John Oldham, O.B.E., the chairman, has been appointed assistant managing director of the company, representing the fourth generation of the Oldham family in the management of the business which was founded by his great-grandfather, Joseph Oldham, in 1865. The company's report also announces the proposed appointment to the board of **Mr. J. Dowse** as production director and **Dr. C. D. J. Statham** as sales director. Mr. Dowse has for twenty years occupied the position of general works manager and Dr. Statham has since 1944 been responsible for the direction and development of the Mining Division; in 1958 he was appointed general sales manager.

Mr. Orlando Oldham

Mr. J. H. Herbert, Southampton manager of Progress Cables & Accessories Co., Ltd., since 1946, has resigned to become manager of a new company, Southampton Electrical Distributors, Ltd., 68, Oxford Street, Southampton, which, as from 1st September, will operate in the field of industrial wholesale distribution.

The annual general meeting of the **Electrical Trades' Commercial Travellers' Association** will be held on Friday, 11th September (6.30 p.m.), at the Feathers Hotel, Broadway, Westminster, S.W.1. A talk on electrical engineering will be given after the meeting.

Mr. G. Devereux, A.M.I.E.E., A.I.Mar.E., is joining the Marine Department (Sales) of Allen West & Co., Ltd., on 1st September. He will be directly responsible to the marine manager, Mr. J. M. L. Slater, and will operate from the company's London office. Mr. Devereux was formerly London manager of Mawdsley's, Ltd.

Mr. L. C. Hoare, A.M.I.E.E., has been appointed general works manager of Merchant Adventurers of London, Ltd. Until his new appointment he was in charge of the X-ray Manufacturing Department at G.E.C.'s Union Works at Wembley.

The **Ipswich and District Electrical Association** recently held its annual works visit, which was made this year to the Atlas Lamp Works, and the Ferguson Radio Works, North London, both of which are part of Thorn Electrical Industries, Ltd. The party of thirty-four members were received by Mr. J. G. Christopher, director, and Mr. R. S. Gowing, area manager, at luncheon, during which the hosts were thanked by Mr. J. A. Robertson, chairman of the Association. After dinner in town the party visited a London theatre.

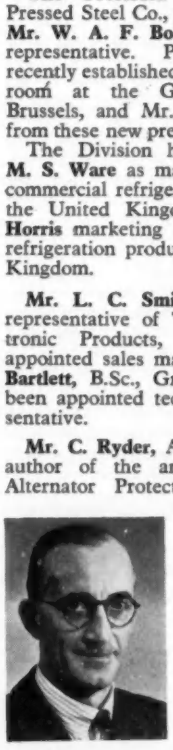
The Minister of Power has reappointed **Mr. A. N. Todd,** A.C.A., as deputy chairman of the London Electricity Board.

The Prestcold Division of the Pressed Steel Co., Ltd., has appointed **Mr. W. A. F. Boin** as its European representative. Pressed Steel S.A. recently established offices and a showroom at the Galerie Ravenstein, Brussels, and Mr. Boin will operate from these new premises.

The Division has appointed **Mr. M. S. Ware** as marketing manager—commercial refrigeration products, for the United Kingdom, and **Mr. M. Horris** marketing manager—domestic refrigeration products, for the United Kingdom.

Mr. L. C. Smith, technical sales representative of Technograph Electronic Products, Ltd., has been appointed sales manager, and **Mr. P. Bartlett,** B.Sc., Graduate I.E.E., has been appointed technical sales representative.

Mr. C. Ryder, A.M.C.T., M.I.E.E., author of the article on "Turbo-Alternator Protection" (page 143), joined the Metropolitan - Vickers Electrical Co., Ltd., in 1919 as a draughtsman in the Instrument and Meter Department. In 1921 he was transferred to the engineering side, dealing with automatic control schemes, and since 1929 he has been responsible for the design and development of protective and control relays. Mr. Ryder was appointed assistant chief engineer, Instrument and Meter Department, in 1950, and chief engineer in 1955. He is a member of several B.E.A.M.A. and B.S.I. technical committees and of the I.E.E. Measurements Section Committee. During the 1952-53 session he was chairman of the I.E.E. North-Western Measurements Group. Mr. Ryder is joint author of a number of I.E.E. papers on protective gear.



Mr. C. Ryder

In our issue of 14th August we reported the election of **Mr. N. G. Saunders,** of the Western Dynamo & Motor Co., as chairman of the Association of Electrical Machinery Trades. We have since received a portrait of Mr. Saunders which we now reproduce.

Mr. N. G. Saunders

Mr. H. G. Stern, A.M.I.E.E., has been appointed a director of Londex, Ltd. For the past six years he has been head of the Control Department.

Mr. L. J. Robinson has been appointed senior street lighting representative of Atlas Lighting, Ltd., covering London and Southern England. Since 1949 Mr. Robinson has been with the Revo Electric Co., Ltd., latterly as area sales manager, Southern Region.

Mr. T. Chamberlain (Liverpool Electric Cable Co., Ltd., Exeter) has been appointed chairman of the Exeter Branch of the Electrical Industries Benevolent Association in succession to **Mr. H. Peters. Mr. R. Turpin** (British Insulated Callender's Cables, Ltd., Exeter) has been appointed hon. secretary of the branch to succeed **Mr. W. S. Mortimer,** who has served in this capacity for the past three and a half years.

Mr. J. T. Palmer, of Nottingham, has been appointed chairman of the Nottinghamshire Branch of the Association in succession to **Mr. P. M. Furse.**

Mr. B. C. Mitchell (L. C. Mitchell & Co. (Gloucester), Ltd.) has been elected hon. treasurer of the Gloucestershire Branch in succession to **Mr. I. E. Morgan.**

Mr. S. R. Gee has been appointed hon. secretary of the West Lancs., Merseyside and N. Wales Branch, and **Mr. R. G. Patterson** (Merseyside and North Wales Electricity Board) has been appointed hon. treasurer.

OBITUARY

Mr. J. F. Galloway, M.B.E., formerly Edinburgh Area engineer, South of Scotland Electricity Board, died on 10th August at the age of sixty-nine. Mr. Galloway served his apprenticeship with Bruce Peebles & Co., Ltd., and joined the mains staff of Edinburgh Corporation Electricity Department in 1912. During the 1914-18 war he held the rank of captain in the Royal Engineers. In 1952 he was awarded the M.B.E. for services to

the industry and he retired in 1956 after forty-four years' service.

Mr. H. I. Chalfont, manager of the Special Lamps Department of Philips Electrical, Ltd., died suddenly on 18th August after a brief illness. Mr. Chalfont, who was sixty years of age, joined Philips Lamps, Ltd., in February, 1928, as a traveller for the Lighting Department. Eight years later he became lamp sales manager, and he took over management of the Special Lamps Department in 1946.

Mr. John Robinson Dunkley, who, until his retirement in 1946, was managing director of J. R. Dunkley & Co., Ltd., Huddersfield, died on 31st July.

Mr. F. O. Harber.—The death occurred on 5th August of Mr. Frank Ollerenshaw Harber, M.I.E.E., district engineer at Oswestry, Salop, with the Merseyside and North Wales Electricity Board; he was sixty-one. Mr. Harber was well known for his project for utilising the tidal power of the Menai Strait. In 1946 he prepared a report for the former Electricity Commission giving details of his scheme which, however, was not proceeded with. At that time he was city electrical engineer of Bangor, Caernarvonshire. He had previously been with the Aylesbury and Portsmouth municipal electricity undertakings. Mr. Harber leaves a widow to whom we extend our sympathy.

Mr. F. T. Jackson.—A memorial service to Mr. F. T. Jackson, chairman and managing director of the Telephone Manufacturing Co., Ltd., whose death we reported in our last issue, was held on Wednesday last at St. Luke's Church, West Norwood.

WILLS

Sir Claude Gibb, F.R.S., chairman and managing director of C. A. Parsons & Co., Ltd., left £294,162 gross (£250,857 net).

Sir John Dalton, M.I.E.E., F.C.I.S., late chairman of W. T. Henley's Telegraph Works Co., Ltd., and former director of the Cable Makers' Association, who died on 14th May last, left £40,172 gross (£38,000 net).

Mr. J. R. Greenwood, chairman and managing director of Craven Brothers (Manchester), Ltd., who died on 14th March last, left £117,186 gross (£88,648 net).

Mr. J. B. Mavor, LL.D., M.I.E.E., M.I.Mech.E., former chairman and managing director of Mavor & Coulson, Ltd., left personal estate in England and Scotland in England and Scotland valued at £41,432.

Professor J. T. MacGregor-Morris, Emeritus Professor of Electrical Engineering, London University, who died on 18th March last, left £15,973 gross (£15,821 net).

Mr. W. A. B. Ames, director of the British Electrical and Manufacturing Co., Ltd., who died on 10th October last, left personal estate in England and Scotland valued at £39,921.

Mrs. Emily Hulme, director of F. Hulme & Co., Ltd., Manchester, who died on 26th October last, left £3,674 gross (£3,617 net).

Mr. F. Ashton, M.B.E., works director of Bulpitt & Sons, Ltd., who died on 12th January last, left £68,291 gross (£62,725 net).

Mr. J. A. Darbyshire, M.Sc., Ph.D., A.M.I.E.E., chief physicist at the Moston factory of Ferranti, Ltd., who died on 8th February last, left £22,181 gross (£22,124 net).

Transatlantic Telephone Cable

An order has been placed with Submarine Cables, Ltd. (owned jointly by Siemens Edison Swan, Ltd., and the Telegraph Construction & Maintenance Co., Ltd.), by Cable & Wireless, Ltd., on behalf of itself and the Canadian Overseas Telecommunication Corporation, for 1,635 nautical miles of lightweight coaxial deep-sea cable for the first section of the Commonwealth round-the-world telephone cable at a cost of approximately £2,300,000.

The cable will be laid between Scotland and Newfoundland in the summer of 1961. It will be a special lightweight non-twisting coaxial cable designed by the Post Office and developed by Submarine Cables, Ltd. Instead of the conventional outer armouring it has a central stranded steel wire. This is enclosed in a copper tube to provide the central conductor, and insulated with polythene to a diameter of approximately 1in. Aluminium tapes (outer conductor) together with a polythene binder tape and one aluminium screening tape with a polythene interleaving tape are applied, and the whole given a lapping of anti-corrosion tape and an outer covering of polythene to an overall diameter of about 1¼in. This type of cable can be handled much more easily than armoured cable and this facilitates the laying of the repeaters.

The estimated total cost of the transatlantic section of the cable, which will carry 60 simultaneous telephone conversations, is £6 million. It is being jointly financed by Cable & Wireless, Ltd., and the Canadian Corporation.

An order for 552 nautical miles of armoured cable for the shallow water stretches and shore-ends was placed in March with Submarine Cables, Ltd., at a cost of £750,000. In May Standard Telephones & Cables, Ltd., was given an order for 92 submerged two-way repeaters and eleven submerged equalisers at a cost of £1,800,000.

Trade Mark Decision

Electrolux, Ltd., informs us that by a decision of 6th July dismissing an appeal by Electrix, Ltd., the House of Lords affirmed a judgment of the Court of Appeal that the name "Electrix" could not be registered as a trade mark for domestic electric vacuum cleaners. The application for registration was opposed by Electrolux, Ltd., which in 1953, in an action against Electrix, Ltd., and the Sterling Engineering Co., Ltd., obtained an injunction restraining the defendants from infringing the Electrolux registered trade mark "Electrux" by the use of the word "Electrix" for vacuum cleaners. The operation of the injunction and an inquiry into damages had been made pending the formal legal application to register "Electrix." The effect of the House of Lords decision is that the injunction against Electrix, Ltd., and the Sterling Engineering Co., Ltd., becomes effective and that the stay on the inquiry into damages has been removed.

New Cable Ship

The first British cable ship to be equipped with diesel-electric main propulsion machinery is to be built by the Fairfield Shipbuilding & Engineering Co. for the Postmaster General. The whole of the propulsion machinery and the six auxiliary generators will be supplied by the Heavy Plant Division of Associated Electrical Industries, Ltd. The ship will have two main 2,200 s.h.p. propeller motors, giving a speed of 15 knots, and will be fitted with a cycloidal propeller mounted in the bows to give additional manœuvrability. Power will be supplied from four diesel-driven main generators each rated 895 kW at 428 r.p.m., the diesel engines being manufactured by Mirrlees, Bickerton & Day under sub-contract. Coupled to each main generator will be a 300 kW auxiliary generator, two further 300 kW auxiliary generators being separately driven by their own diesel engines.

The ship is intended for use mainly on deep-sea cable repairs and maintenance, especially in the Atlantic, and will replace the 44-year-old German-built *Alert*.

Prices of Materials

In the accompanying table we give the basis prices of the more important materials used in the electrical industry. The figures given are the selling prices and are those quoted on Tuesday last.

ALUMINIUM ingots	ton £180 0s 0d
COPPER, H.C. Electro	ton £231 0s 0d
Fire Refined 99·70%	ton £230 0s 0d
Fire Refined 99·50%	ton £229 0s 0d
COPPER Tubes ..	lb 2s 3½d
Sheet	ton £261 0s 0d
H.C. wire and strip..	ton £288 15s 0d
LEAD, English ..	ton £73 5s 0d
Foreign	ton £72 0s 0d
MERCURY	flask £72 0s 0d
TIN, block (English) ..	ton £792 10s 0d
ZINC, G.O.B. Foreign	ton £85 10s 0d
BRASS Tubes (solid drawn)	lb 1s 10½d
Wire	lb 2s 8d
PHOSPHOR BRONZE Wire	lb 4s 0d
PLATINUM	oz £28 10s 0d
RUBBER, No. 1 R.S.S. spot	lb 31½d—31¾d

"Hydrox" Fuel Cell

Further Development Awaiting Commercial Exploitation

AFTER twenty-seven years of research and general development by Mr. F. T. Bacon at Cambridge University, the feasibility of the hydrogen-oxygen fuel cell has been proved and its application now awaits further development by industry. The long period required to reach this stage has been ascribed to lack of funds and interest. Last Monday, a prototype cell, producing 5 kW at 24 V, was demonstrated. It is the most advanced fuel cell in the world and the first to become a practical commercial proposal. This lead can be retained only if British industry now undertakes commercial exploitation of the cell. Already, one company in America is producing fuel cells for military purposes, under licence from Britain, and a large development programme is under way.

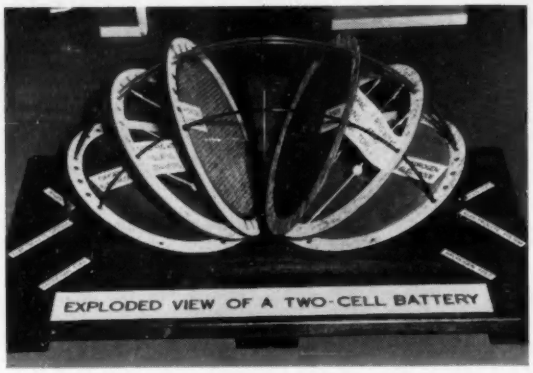
The direct conversion of chemical energy into electrical energy is accomplished in a conventional primary cell. In a dry battery, electricity is derived from the oxidation of the zinc element, but in a fuel cell the reaction is the oxidation of a natural or derived fuel. The Bacon "Hydrox" fuel cell consists of two circular nickel electrodes and an electrolyte of a 40 per cent solution of potassium hydroxide. The electrodes, which are not consumed in the reaction, are made of porous sintered nickel with a thin layer of a smaller pore size nickel on the liquid side. The oxygen electrode is treated with lithium and pre-oxidised to prevent corrosion. Hydrogen and oxygen enter the cell from opposite sides behind their respective electrodes. The electrolyte soaks into the sintered metal but, on the application of the hydrogen and oxygen gases under pressure from the back of the plates, it is repelled from the larger pores on the gas side. The gas cannot bubble through the smaller-pored surface on the liquid side owing to the surface tension of the liquid. There is, thus, a very large surface of wetted, sintered metal in contact with the gas in each electrode—about 40 sq metres for a 10in diameter electrode.

Oxygen molecules on the positive electrode combine with the water of the electrolyte to form negatively charged hydroxyl ions which each remove an electron from the oxygen electrode. The hyroxyl ions migrate through the electrolyte to the negative electrode where they combine with the hydrogen to form water, depositing an electron in the process. Thus, the hydrogen electrode becomes negatively charged with respect to the oxygen electrode and a current flows in the external circuit. Basically the reactions involved are:—

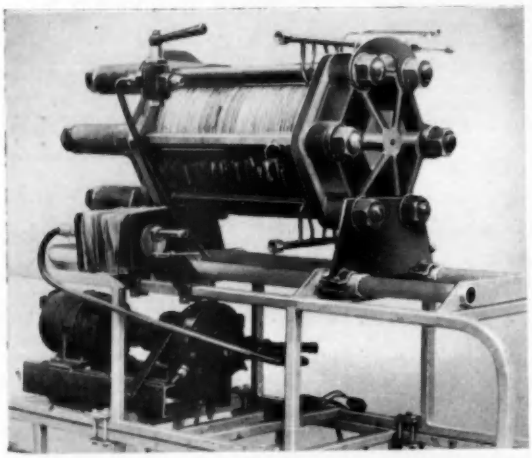
+ve Oxygen electrode: $-e + O_2 + 2H_2O \rightarrow 4OH^-$

−ve Hydrogen electrode: $-2OH^- + H_2 \rightarrow 2H_2O + e$

These chemical reactions, which must not be confused with combustion, require a high temperature for economic operation. To start the reaction, the cell is heated by external means. If a large enough cell is operated, the self-generated heat from the reactions can be sufficient to keep the temperature at the required level. At the demonstration last Monday, the working conditions of the prototype cell were around 200 deg C and 400 p.s.i. On full load, excess heat is generated by the reaction and is removed by cooling the exhaust from the hydrogen side of the cell. The water formed on the hydrogen electrode appears as steam and is condensed at a rate of 0·45 litre of water per kWh.



Exploded view of a two-cell "Hydrox" battery



The prototype 40-cell "Hydrox" battery. The hydrogen circulator and condenser for water removal are mounted below the cell

The prototype unit consists of 40 cells of 10in diameter placed in a 30in horizontal stack with p.t.f.e. insulation between cells. It is continuously charged with the fuel gases which flow along "busbars." The electrolyte is also circulated at about 398 p.s.i. In this cell, the power output appears to be limited by the amount of fuel which can be circulated and the efficient removal of the self-generated heat. The cell is normally operated at about 80 A, giving 0·8 V per cell and a total rating of 2½ kW for 40 cells. For short periods, it can operate at about 200 A at 0·6 V per cell giving a total rating of 5 kW at 24 V. On one very short occasion, a maximum of 320 A was reached. The cell uses 1 lb of fuel (one-tenth hydrogen, nine-tenths oxygen) per kWh at an efficiency of 65 per cent, giving a running cost of 4d/kWh (3d being the cost of the hydrogen).

Advantages of the fuel cell are that it can supply a load at a moment's notice; it can sustain large overloads

at reduced efficiency without damage; it is silent and free from vibration in operation; it has very few moving parts; the "exhaust" is only water; and it could act as either a primary or secondary battery. Its disadvantages are that a complicated control system is required to balance the pressure of the two gases and maintain the correct temperature; except for special applications, such as space vehicles, it is at present an uneconomic form of generator; the electrolyte is corrosive and a leakage could be serious; and, although the cell itself is lighter than an equivalent traction battery (about 600 lb) the total weight with the control gear is much greater.

The present gas pressure control system uses conventional pressure differential relays. The oxygen pressure is kept constant and that of the hydrogen is controlled to within ± 10in water gauge by a very accurate differential pressure meter actuating a power-operated inlet valve controlled by a servo-mechanism. Commercial development of the control apparatus would reduce its size and weight. From the economic aspect, the cost of hydrogen would probably fall if it was required on a large scale. It has been stated that the weight of the prototype cell could be reduced by one-third for commercial applications.

Possible applications of fuel cells are many, but cells with outputs of less than 100 W are not likely to be economic. The main application, at first, would be for heavy traction. One interesting idea is to use fuel cells as secondary batteries for electricity storage to smooth out the national load curves. At off-peak periods, surplus electricity could be used for electrolysis to provide "fuel" for cells during peak periods. The efficiency of this process could be developed to reach 60 per cent overall, but the same apparatus could not perform both functions.

From 1946 to 1956, the work on the "Hydrox" cell was financed by the Electrical Research Association to the extent of £2,000 per annum, and its technical committee advised on the work being carried out by Mr. Bacon at Cambridge. Patents were taken out by the E.R.A. in 1952 and since 1957 the work has been supported by the National Research Development Corporation. In 1957, the N.R.D.C. placed a development contract with Marshall of Cambridge Electronics, Ltd. In the two years since then the N.R.D.C. has spent £80,000 on the project while in the last few months America has spent twenty times this sum. The Universal Winding Co., U.S.A., has become a licensee of the N.R.D.C. and has manufactured units for the U.S.A.A.F.

Automatic gas control gear for the cell, with Mr. F. T. Bacon, the inventor, standing

Development is also proceeding at the Sondes Place Research Institute in Dorking under the auspices of the Ministry of Power and Shell Research, Ltd., of a cell using hydrocarbon vapour and air with a molten electrolyte supported in a sheet of porous magnesia for the generation of electricity.

LETTER TO THE EDITOR

Letters should bear the writers' names and addresses, not necessarily for publication. Responsibility cannot be accepted for the opinions expressed by correspondents.

Electricity and Agricultural Shows

WE were interested to read your article on agricultural shows (14th August issue) but we do feel that your subjects are mainly from the Electricity Board angle.

We would like to point out that the complete electrical installation at the Royal Show was carried out by this company, that is, the whole of the l.v. substations were erected consisting of two 500 kVA and two 300 kVA transformers, and the whole of the overhead network. Each stand having electricity was wired by this company and the British Electrical Development Association stand was wired by one of our sub-contractors. The electrical installation for the whole of the Society's buildings, including the kitchens for the dining marquees, was also carried out by this company.

The Great Yorkshire Show is a more permanent one, and on this particular showground we take a supply at high voltage and we have installed in our own permanent substation a 70 kVA transformer. Part of the network is overhead and part is underground and, here again, the whole of the installation, both Society's buildings and exhibitors' stands, permanent and temporary, have been wired by this company.

We also point out that we are sole electrical contractors for the Bath and West Show and the Lincolnshire Show.

Filey, Yorks. LEONARD H. DALE, *Managing Director*, Dale Electric (Yorkshire), Ltd.

I.E.E. Special General Meeting

A SPECIAL general meeting of corporate members of the Institution of Electrical Engineers was held on 18th August. At this meeting, which was attended by 542 members, a resolution of the Council proposing increases in annual subscriptions was offered for confirmation. At a previous special general meeting on 25th June a similar proposal was put forward for adoption but was defeated at a subsequent poll on 9th July. The result of that poll was 423 in favour (335 personal and 88 proxy) and 739 against (349 personal and 390 proxy).

After a discussion contributed to by 13 speakers, a show of hands was taken at the 18th August meeting; 369 voted in favour and 139 voted against the resolution. A poll was then demanded by three of the members present and this, on the direction of the President (Mr. S. E. Goodall), as chairman of the meeting, was taken forthwith. The result of the poll was 4,701 in favour (302 personal and 4,399 proxy) and 736 against (83 personal and 653 proxy).

In the course of the meeting, the President stated that he had decided to recommend to the Council the setting up of a special committee to consider the many proposals and comments which had been put forward by members not only at the three special general meetings but also in the extensive correspondence which had been received. He was confident that the Council would take this action and that, with the assistance of the successive reports of this committee, the Council would be able to report to members during the coming session on the action they were taking.

Financial Section

STOCKS and SHARES

STRONG and active conditions have continued to prevail in most sections of the Stock Exchange: by the beginning of this week the indices to industrial share prices had risen to yet another record height. Optimism about the ecoromic outlook found authoritative confirmation in the Treasury's latest "Bulletin for Industry," while popular opinion polls encouraged confidence in the present Government's chances of remaining in office. Investment demand has again tended to pay rather more attention to the capital equipment sections, which hitherto have lagged behind those concerned with consumer goods. It is the latter, however, which still claim the larger share of attention on the strength of such items of news as the report that over a million new television sets (80 per cent more than last year's comparable figure) were sold in the first six months of 1959.

Pye Capital

Latest returns from the industry induced another all-round advance in the section of the market still known under the inadequate description of the "radio group." Pye 5s shares, always one of its most active members, were advanced further to 15s 6d. This company has just completed a "rights" issue of new shares which produced some £3¾ million new money, part of it required for financing the rapid development of business in the renting of television sets and an increase in the company's investment in British Relay Wireless and Television. Following a marked improvement in profits for the twelve months ended last March, the group's orders and sales in the current year have been running above the previous corresponding level, and the directors hope at least to maintain the present 12½ per cent rate of dividend on the increased capital. This indicates a yield of not less than 4 per cent on the shares at their present price.

"Radio" Shares

Thorn Electrical Industries 5s shares added 3s 3d to the previous week's advance of 2s 6d, reaching 39s 6d, on further consideration of the chairman's review of prospects in the annual report. This anticipated a record year on the radio and television sides of the business. Based on the present 20 per cent dividend, the yield on the shares is no more than 2½ per cent, but the position is conditional upon the terms of the company's plans for raising £5½ million new capital, partly in the form of a "rights" issue of ordinary shares. In the same section of the market, Decca "A" shares were in favour, and 2s 9d up at 38s 9d, while Ever Ready put on yet another 2s, to 26s, and E. K. Cole improved to 22s 6d. The 5s shares of Radio & Allied Holdings (with interests in the makers of Sobell and McMichael sets) have been quoted recently at about 21s 3d to yield 5¼ per cent on the 22½ per cent dividend.

Domestic and Car Equipment

Morphy-Richards 4s shares have lately been the subject of much

Price Changes in

Company or Board	Nom. Value	Middle price 24th Aug.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield %	1959 Highest	1959 Lowest
Gilt-edged Stocks						£ s d		
Brit. Elec. 1968/73	100	80½	+1	3	3	3 14 6	80½	77½
Brit. Elec. 1974/77	100	76	+½	3	3	3 19 0	77	74½
Brit. Elec. 1976/79	100	80½		3½	3½	4 7 0	80½	77½
Brit. Elec. 1974/79	100	89½	−1½	4½	4½	4 15 0	91	87½
Overseas Electric Supply								
Calcutta Elec.	£1	19/-		6·8†	7†	11 18 0	19/6	16/-
East African Power	£1	20/6		7½	8	7 16 0	22/3	19/3
Nigerian Elec.	£1	13/6		8	8	11 17 0	15/-	13/-
Perak Hydro-Elec.	£1	15/-	+1/-	12½	10	13 6 9	15/-	12/3
Electrical Shares								
Aberdare Holdings	5/-	16/9		17½	17½	5 4 6	16/9	15/6
Aerialite	1/-	8/9	+3d	51½	54	5 18 0	9/6	7/9
Allen, W. H.	£1	51/3		11	12	4 13 9	51/3	43/-
Allied Insulators	5/-	20/-		—	20‡	5 0 0	20/-	18/9
Anglo-Portuguese Tel.	£1	29/-		9	9	6 4 3	29/3	26/6
Aron Elec. Ord.	£1	56/3	+1/3	15	15	5 6 9	62/6	55/-
Assoc. Elec. Ord.	£1	62/9	−3d	15	15	4 15 6	63/6	53/9
Automatic Tel. & El.	£1	75/-		17	17‡	4 10 9	82/6	71/3
Babcock & Wilcox	£1	53/-	−9d	13½	13	4 18 0	54/6	45/6
Bakelite	10/-	31/3		15	15	4 16 0	31/3	22/-
Baldwin, H. J.	2/-	2/3		20	20	—	3/-	2/3
Berry's Electric	5/-	29/6	+1/-	10	20	3 7 9	29/6	10/9
Bowthorpe Holdings	2/-	14/9	+9d	25	27	3 13 0	15/6	11/9
British Elec. Traction: Def. Ord. "A"	5/-	39/-	+6d	25	35	4 9 9	40/-	35/6
B.I. Callender's	£1	53/-	+1/-	12½	13½	5 2 0	56/6	44/9
B.I. Callender's 6% Pref.	£1	20/6	+6d	6	6	5 17 0	20/6	19/9
British Thermostat	5/-	25/6	+1/-	30	35	3 8 9*	25/6	18/6
British Vac. Cleaner	5/-	7/9	+9d	10	7½*	4 16 9	7/9	4/6
Brook Motors	10/-	50/-	+1/3	25	24½*	4 16 6	54/3	46/-
Bulgin, A. F.	1/-	9/9	+9d	45	50	5 2 6	10/-	6/9
Bulpitts	5/-	18/3		—	15	4 2 3	18/3	10/-
Burco Dean	5/-	15/9		22½	16*	5 1 6	15/9	12/3
Cable & Wireless: Ord.	5/-	16/-	+1/-	10	10*	3 2 6	16/-	12/3
4% Loan	100	94½		4	4	4 4 9	95	93
Chloride El. Storage "A"	£1	57/6	+2/6	17½	20‡	4 12 6*	57/6	43/8
Clarke Chapman	£1	53/9	+1/3	27½	13½*	5 2 3	66/3	52/6
Cole, E. K.	5/-	22/6	+1/3	17½	20	4 9 0	22/6	17/3
Contactor Switchgear	5/-	15/-		20	14*	4 13 3	15/-	12/-
Cossor, A. C.	5/-	8/3		2½	Nil	Nil	9/-	6/3
Crabtree	10/-	30/3		20	20	6 12 3	31/6	28/-
Crompton Parkinson	5/-	14/3	+6d	16	12*	4 4 3	14/3	11/9
Davis & Timmins	5/-	17/-		18	20	5 17 9	17/-	14/6
De La Rue	10/-	52/-	+2/-	17½	20	3 17 0	54/-	30/3
Decca "A"	10/-	38/9	+2/9	43½	50	5 3 3*	40/3	33/3
Desoutter	5/-	27/6		32½	21‖*‡	3 18 9	27/6	19/-
Dewhurst	2/-	8/3		20	20	4 16 9	8/3	7/3
Dictograph Tel.	2/-	7/6		20	20	5 6 9	8/3	7/-
Dubilier Condenser	1/-	4/6		20	25	5 11 0	5/-	3/3
Duport	5/-	13/3	+6d	25	12½*	4 14 3	13/3	10/3
E.M.I.	10/-	51/9		15	20*†	3 17 3	64/6	48/-
Electrical Apparatus	5/-	13/9		12½	14½	5 5 6	14/-	13/-
Electrical Components	5/-	15/9		12½	15	4 15 3	15/9	10/6
Elec. Construction	£1	33/6		8½	9	5 7 6	33/6	27/9
Elliott-Automation	5/-	23/9		—	10‡	2 2 0	30/6	16/9
Enfield Cable Ord.	£1	21/3		2½	Nil	—	22/3	16/3
English Electric	£1	45/-		14	14	4 3 0*	45/-	37/10
English Electric 3½% Pref.	£1	13/-		3½	3½	5 15 6	12/9	12/3
Ericsson Tel.	5/-	22/3		12†	13†	5 1 6	27/3	22/3
Ever Ready	5/-	26/-	+2/-	20	27½‡	3 3 6*	24/-	13/3
Falk Stadelmann	£1	25/-		17½	10*‡	8 0 0	32/9	25/-

The above quotations are based upon middle prices in the Stock Exchange Daily Official List.
* After scrip issue. † Free of income tax. ‡ Dividend indicated.

attention and have risen to 29s 9d, after being over 30s at one time. Other improvements in shares associated with domestic equipment included those in Hoover, to 76s, British Vacuum Cleaner to 7s 9d, Plessey to 33s and Pressed Steel to 32s. Berry's Electric Magicoal added 1s 6d to previous remarkable rises, reaching 29s 6d, which is approaching three times this year's lowest quotation. Vactric were also notably strong at 46s 3d. In the field of motor car accessories, S. Smith and J. Lucas continued firmly in the ascendant, to 17s 6d and 55s respectively, while Chloride Electrical Storage, at 57s 6d, gained half a crown for the second week in succession.

Electrical Investments

Company or Board	Nom. Value	Middle Price 24th Aug.	Week's Rise or Fall	Dividend Previous	Dividend Last	Yield % £ s d	1959 Highest	1959 Lowest
Electrical Shares—continued								
G.E.C.	£1	37/6		10	10	5 6 9	40/3	31/3
G.E.C. 6½% Pref.	£1	22/-		6½	6½	5 18 3	22/-	20/3
General Cables	5/-	8/3		24	15	9 2 0	9/3	7/6
Greenwood & Batley	£1	105/-		20	30	5 14 3	105/-	75/-
Hackbridge Holdings	5/-	16/6x.d.		20	20	6 1 3	19/3	14/3
Hackbridge & Hewittic	5/-	13/6		20	20	5 11 0*	13/6	10/6
Head Wrightson	5/-	32/-	+2/6	17½	20	3 2 6	32/-	24/3
Heatrae	2/-	8/-		20	20	5 0 0	10/-	7/6
Holophane	5/-	18/9	+1/3	37½	22½*	6 0 0	18/9	14/9
Hoover	5/-	76/-	+1/6	50	60	3 19 0	76/-	55/-
I.C.I.	£1	40/-		12	8*	4 1 0	40/-	33/-
Intl. Combustion	5/-	33/9		25	30‡	4 9 0	36/6	29/9
Intl. Computers & T.	£1	65/6		—	8‡	2 8 9	78/9	57/6
Johnson & Phillips	£1	22/-	−6d	5	5	4 11 0	30/6	22/-
Lancashire Dynamo	£1	42/6		11	12½‡	4 8 3*	43/1	31/6
Laurence Scott	5/-	16/9		15	15	3 3 9*	16/9	14/-
Lister, R. A.	£1	40/-	+6d	10	12½	6 5 0	41/-	32/9
Lucas, J.	£1	55/-	+2/6	7½	10‡	3 12 9	52/6	43/3
Marconi Marine	£1	42/-		10	10	4 15 3	48/6	40/-
Marryat & Scott	2/-	9/9		37½	22½*	4 12 3	10/-	8/6
Mather & Platt	£1	44/6	+1/6	15	10‡*	4 15 9	51/6	41/3
Metal Industries	£1	56/3	+6d	14	14	4 19 6	56/3	39/9
Midland Elec. Mfg.	£1	46/-	+1/-	12½	10*	4 7 0	46/-	41/6
Morphy-Richards	4/-	29/9	+1/9	20	20	2 13 9	30/6	18/-
Murex	£1	46/3x.d.		17½	15	6 9 9	49/6	42/-
Newman Ind.	2/-	3/6		10	10	5 14 3	3/6	2/3
Oldham & Son	1/-	2/9		17½	17½	6 7 3	3/-	2/6
Parsons, C. A.	£1	49/-	+2/6	7½	8½‡	3 6 6	55/9	45/9
Philips' Lamps	Fl.10	122/6		14	14	2 3 0	126/3	88/-
Plessey	10/-	33/-	+6d	30	30	3 0 6*	33/-	23/6
Pye	5/-	15/6	+1/-	12½	12½	4 0 9	16/9	13/9
Pyrotenax	5/-	37/6	+6d	—	34	4 10 9	38/3	33/9
Reliance Clifton	5/-	23/-	+1/-	15	15	3 5 3	23/-	17/6
Reyrolle	£1	90/-	+1/3	17½	17½	3 17 9	98/-	85/9
Rheostatic	4/-	10/6	+9d	12½	12½	4 15 3	10/9	8/3
Richardsons Westgarth	10/-	12/6	+6d	8½	8½	6 13 0	15/3	12/-
Simon-Carves	5/-	28/9		25	25	4 7 0	32/-	28/6
Smith (England), S.	4/-	17/6	+1/3	20	12½*‡	2 17 3	17/6	11/6
Southern Areas	£1	14/6	+1/-	Nil	Nil	Nil	15/-	10/6
Strand Elec.	5/-	10/9	+6d	15	15	6 19 6	10/9	8/6
Sturtevant	5/-	18/-	+3d	15†	15†	6 16 0	20/-	17/-
Sun Elec.	5/-	15/9		25	25	3 19 3*	15/9	8/3
Switchgear & Cowans	5/-	13/9		22½	15*	5 9 0	13/9	10/3
T.C.C.	10/-	43/9		25	25	5 14 3	43/9	38/-
Telephone Mfg.	5/-	6/3		10	10	8 0 0	6/3	4/9
Telephone Rentals	5/-	17/-	+3d	12½	12½*	3 13 6	17/-	11/9
Thompson (John)	5/-	21/9	+9d	25	25	5 15 0	25/6	22/9
Thorn Elec.	5/-	39/6	+3/3	17½	20	2 10 9	40/-	26/3
Thornycroft	£1	27/6	−2/6	12½	7½	5 9 0	30/-	20/6
Tube Investments	£1	90/-	+2/3	15	17½	3 17 9	90/-	71/6
Vactric	5/-	46/3	+5/3	25	37½	4 1 0	46/6	26/3
Veritys	5/-	1/6		12½	2½	—	5/-	1/3
Walsall Conduits	4/-	12/6	+6d	22½	22½	4 2 0*	14/2	10/8
Ward & Goldstone	5/-	45/6	+1/6	25	30	3 6 0	45/6	30/6
Watford	2/-	9/6	+3d	25	25*	5 5 3	9/3	7/6
Westinghouse	£1	43/6	+1/-	10	10	4 12 0	47/-	39/6
West, Allen	5/-	12/9	+3d	12½	11‡*	4 11 0	14/-	11/9
Wolf Electric	5/-	8/3	+6d	10	10	6 1 3	8/6	7/9

Allied Insulators

Dealings are being recorded at a little over 20s in the 5s ordinary shares of Allied Insulators, the company formed a few months ago to implement the merger between the operating companies of the Taylor Tunnicliff group and Bullers, Ltd. First accounts of the new group are to be made up to the end of next December. They were expected by the directors, at the time of the merger, to show profits in the neighbourhood of half a million for the calendar year 1959. Advantages of the merger would take time to materialise, but were confidently expected to become effective in the course of time. Dividends totalling 20 per cent (including an interim payment next October) were envisaged for 1959. Such a distribution would be covered more than twice by the estimated earnings, and would show a yield of approximately 5 per cent on the shares at their present price.

Dubilier Condenser

At the annual meeting of Dubilier Condenser, the chairman reported higher sales in the first quarter of the current year. With the aid of greater production efficiency to counter lower margins of profit, and of new products about to be introduced, he thought that a satisfactory year could be expected. For the period ended last March, there was some contraction of the trading profit, but after a smaller tax charge the net surplus was slightly higher than before at £130,000. The ordinary dividend was raised from 20 to 25 per cent and was covered well over twice by earnings available. Quoted at 4s 6d, the 1s shares show a yield of a fraction over 5½ per cent.

Metal Industries

For Metal Industries last year was described by the chairman as a period of transition, during which the company disposed of its holding of 1½ million British Oxygen shares and, with this addition to its financial resources, acquired subsequently the businesses of Towler Bros. and Avo (together with their subsidiaries). Income was reduced by about £100,000 through the disposal of the British Oxygen shares and while the new acquisitions are expected to produce more than compensation for this, their contributions will not be fully reflected until the next accounts. Trading profits for 1958–9 were consequently below the record figures of the previous year, but the dividend is being repeated at 14 per cent with more than twofold cover. Sir Charles Westlake told shareholders that this year's profits to date had been significantly higher than the previous corresponding level, and he described prospects in general for the current year as good. The yield on the £1 shares at 56s 3d is 5 per cent.

REPORTS and DIVIDENDS

Ruston & Hornsby, Ltd.—In his statement, circulated with the report and accounts for the year ended 31st March last, Mr. J. W. Ruston (chairman) says the results of the year show a fall of £594,200 in the earnings of the group. Whilst output has been at a slightly lower level than the previous year the fall in earnings is more than proportionate and is due to the continuing upward trend of costs.

There has been some reduction in output. They started the year with the markets in the Middle East almost closed but there has been some recent improvement, the effects of which, however, were not early enough substantially to affect the results. They have received some good orders from Egypt and he is hopeful that this market will continue to expand. Likewise, in Saudi-Arabia they are recovering once more business that had temporarily been lost.

The order book has shrunk further and the directors are investigating every means of reducing costs through economies. During the year they closed the foundry in Grantham in order to concentrate their casting work in the Lincoln foundries and it may be that further contraction of capacity will have to be considered.

Dubilier Condenser Co. (1925), Ltd.—The annual meeting was held on 19th August, Mr. F. H. McCrea (chairman and managing director) presiding. In his statement, which had been previously circulated, the chairman said that trading conditions in the year under review were highly competitive in all markets which resulted in their having to quote lower selling prices and there was a lower margin of profit. The removal of credit restrictions towards the end of 1958 stimulated the demands made on them by their customers in the radio and television industry to which a large proportion of their total output was sold. They had developed a large export business, although some of the selling prices were unremunerative. With regard to prospects, the sales turnover at the end of the first three months of the current financial year was higher than for the corresponding period of last year. To offset lower selling prices, they were expecting to introduce several new products.

Dowty Group, Ltd.—The group profit for the year ended 31st March last is £2,166,848, as compared with £2,018,430 for the previous year, and after deducting £1,088,709 for taxation, the net balance is £1,078,139 (against £928,472). Two interim dividends totalling 11½ per cent have been paid.

In the course of his circulated statement, Sir George Dowty (chairman) says that the work for the first reactor at Berkeley has been completed and much of it is now installed. They are engaged on other projects which are fully occupying their technical teams, but the nuclear energy industry is fast becoming a paper-work industry of tenders and quotations. The total national effort devoted to the preparation of tenders for this complex technical equipment often approaches the total value of the contract. The amount of development and research effort that has been put into many fruitless projects is a depressing and costly feature of this business. Companies that have entered the nuclear industry have contributed much but have received relatively little in return for their investment in design and development. Unless there is some revision of national policy, much of this technical effort will have to be discontinued, with serious effects upon this new industry both at home and abroad.

Oldham & Son, Ltd.—Dealing with the parent company's affairs in his statement to be presented at the annual meeting on 16th September, Mr. John Oldham (chairman) says that two factors have been concerned in reducing, temporarily, he believes, the demand for the company's products in the home and export sections of the mining division and the export section of the battery division. They are the accumulation of coal stocks, necessitating curtailment of output; and the fact that, in the highly competitive automobile battery export business intensive bids from a number of new sources, including Iron Curtain countries, have temporarily succeeded in capturing a share of the trade. Surveying current tendencies and future prospects, however, the chairman regards the future with confidence. In referring to the "Pg" double sleeve type power and traction battery, he says that sales are now steadily expanding and during the past year many varieties of this type of battery have gone into service at home and overseas. As its advantages are established in everyday working use, he looks forward to a steadily increasing application and demand for this latest addition to the company's range.

Radio & Television Trust, Ltd.—Mr. D. D. Prenn, head of Truvox, Ltd., announces that he has completed arrangements with Crompton Parkinson, Ltd., under which he is acquiring at a price of nearly £500,000 all that company's interest in the Radio & Television Trust. Mr. J. V. Daniel, a director of Crompton Parkinson, has resigned from the board of the Trust, and Mr. Prenn has been appointed a director.

The Palestine Electric Corporation, Ltd., reports profits for the year ended 31st March last of I.£3,115,408, as compared with I.£1,462,785 for the preceding year. It is proposed to pay a dividend of 5 per cent (against 4 per cent) for the year on the ordinary and "A" ordinary capital, and a first payment of 2 per cent on the "B" ordinary capital, issued during 1958 to the Government of Israel in satisfaction of a debt. The company is not liable to United Kingdom taxation on its trading profits.

Pinchin, Johnson & Associates, Ltd.—In his review of the year ended 31st March last, Sir Horace W. Clarke (chairman) says that sales in the United Kingdom again reached a record level, but the progress of some of the subsidiary companies operating overseas was retarded by special factors and group sales did not reach the previous year's level.

The London Electrical & General Trust, Ltd., reports a net revenue for the year to 30th June last, after deducting £68,883 for taxation, of £96,544, as compared with £79,125 for the preceding year. It is proposed to pay a final dividend of 12 per cent, making 16 per cent on increased capital (against a total of 15 per cent on smaller capital).

New Companies

Moffats, Ltd.—Registered 26th June. Capital £100. Exporters, importers and manufacturers of and wholesale and retail dealers in electric cooking apparatus, etc. Directors: V. A. Cowan and A. L. Leddiman. Solicitors: Allen & Overy, 3, Finch Lane, E.C.3.

Cherry Electric Co., Ltd.—Registered 22nd June. Capital £1,000. Electrical contractors and engineers, etc. Directors: E. M. Williams and Winifred Williams. Regd. office: 134, Edwards Road, Erdington, Birmingham.

Bernie & Co., Ltd.—Registered 22nd June. Capital £500. Electrical engineers and contractors, etc. E. J. Bennett is the first director. Regd. office: 371, Bordesley Green, Birmingham, 9.

Liquidations

John McNally & Co., Ltd., electrical distributors, 29, Friar Lane, Leicester.—Winding up voluntarily. Liquidator, Mr. R. A. Haigh, Court Chambers, Friar Lane, Leicester, appointed 10th August. Particulars of claims to the liquidator by 30th September.

M.B.C. Electrics, Ltd., retailers of electrical appliances, 50, Fountain Street, Manchester, 2.—Winding up voluntarily. Liquidator, Mr. L. H. Shipton, 31, Lloyd Street, Manchester, 2, appointed 10th August.

President Electrical Appliances, Ltd.—Pursuant to subsection (1) of section 300 of the Companies Act, 1948, general meetings of the company and creditors will be held on 14th September at 4, Charterhouse Square, London, E.C.1, to receive an account of the winding-up of the company.

Bankruptcies

A. A. Childs, formerly carrying on business under the style of Vac Rebuilds at 19, Slater Street, Liverpool, electrical dealer.—Public examination 6th October at the Court House, India Buildings, Water Street, Liverpool, 2.

F. Jones and **B. P. Callaghan**, formerly trading in co-partnership at 2, Farm Yard, Levenshulme, Manchester, under the style of Jones & Callaghan, electrical engineers and sheet metal workers (separate application of B. P. Callaghan).—Order made 20th July that B. P. Callaghan be discharged subject to consenting to judgment being entered against him by the Official Receiver for the sum of £20 and £1 10s costs.

Turbo-Alternator Protection

2.—The Protection of Steam Turbine Driven A.C. Generators for Main Stations

By C. RYDER, A.M.C.T., M.I.E.E.*

Faults affecting a.c. generators are fortunately rare but when they do occur they must be detected immediately. This is done by protective devices whose function is to bring about automatic disconnection of the machine if the fault is internal or if external conditions are so abnormal that continued operation would result in damage. This second article (the first appeared on 14th August) describes generator protective gear but its scope is extended, where necessary, to cover overall protection of generator-transformer units

MODERN methods of construction of large turbo-generators coupled with gas or liquid cooling enable much more efficient use of material to be made with a consequent reduction in size and weight per kVA. This is very desirable, but makes it all the more necessary to study protective requirements carefully, as these have to take into account a wider range of thermal characteristics and in most cases a greater sensitivity to unbalanced loading conditions.

It is not possible to measure all hazards or dangerous conditions of operation with one device or protective system, and a number are usually employed which collectively guard against the risks associated with a particular application. Before discussing protective schemes or devices a review of the hazards is desirable, as it is important that these should be understood when considering the advisability or otherwise of applying specific protective features.

Stator Faults.—Breakdown of winding insulation results in either a fault to earth, a short circuit between turns, or a short circuit between phases. Other faults originating from defective joints or inadequate or defective bracing of end turns or terminals will, if undetected, develop to the stage where there is a breakdown of insulation.

A fault to earth is most likely to occur in the slot portion of a winding, with consequent arcing to the core at the point of the fault. In addition to conductor damage, burning and welding of the laminations occurs, and while replacement of a conductor bar is serious enough, extensive damage to the laminations may result in having to rebuild the core down to the fault. To limit the damage as much as possible it is almost universal practice to connect an impedance or earthing resistance between the generator winding neutral point and earth. Practice varies somewhat in the value of impedance used, ranging from the passage of rated current on the one hand to a low value on the other, with a full phase-to-earth short circuit.

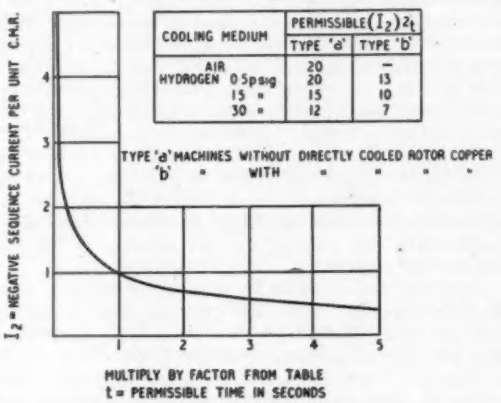

COOLING MEDIUM
PERMISSIBLE $(I_2)^2t$
TYPE 'a'
TYPE 'b'
AIR 20 —
HYDROGEN 0·5 psig 20 13
15 " 15 10
30 " 12 7
TYPE 'a' MACHINES WITHOUT DIRECTLY COOLED ROTOR COPPER
'b' " WITH " " " "
I_2 = NEGATIVE SEQUENCE CURRENT PER UNIT C.M.R.
MULTIPLY BY FACTOR FROM TABLE
t = PERMISSIBLE TIME IN SECONDS

Fig. 1.—Typical negative sequence time/current curve for turbo-generators

Phase-phase or three-phase short circuit currents are not limited by the earthing impedance. Because of the severity of the shock both to machine and system, extra care in maintaining the quality of the insulation at the end windings, terminals, and associated copper work is more than justified.

Unbalanced Loading.—A three-phase balanced load produces a reaction field which to a first approximation is constant and rotates synchronously with the rotor field system. Any unbalanced condition can be resolved into positive, negative and zero sequence components.

The positive sequence component is similar to the normal balanced load. The negative sequence component is similar except that the resulting reaction field rotates counter to the d.c. field system and produces a flux which cuts the rotor at twice the rotational velocity. Double-frequency currents are thus induced in the field system and in the rotor body. The resulting "eddy" currents are very large and result in severe heating of the rotors. So severe is this effect that a single-phase load equal to the normal three-phase rated current can quickly heat the rotor slot wedges to the softening point, resulting in their extrusion by centrifugal force to the point where they may strike the stator iron. Concentration of heating also occurs on portions of end-bells, and surface fusion has been known to occur. The amount of negative sequence current which can be carried for a given period of time by typical designs of turbo-generator is indicated in Fig. 1.

Rotor Faults.—The field system is not normally connected to earth; in consequence, an earth fault does not give rise to any fault current and is not in itself a danger. If a second earth fault should occur, however, a portion of the field winding may be short circuited, resulting in an unbalanced magnetic pull on the rotor. This force may cause excess pressure on bearings, with consequent

* A.E.I. Turbine-Generator Division and Metropolitan-Vickers Electrical Co., Ltd.

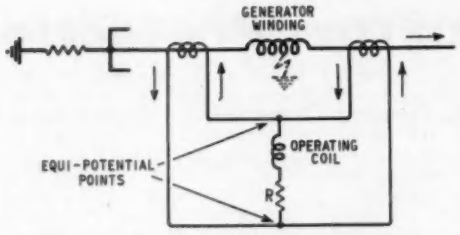


Fig. 2.—Basic circuit of circulating current scheme

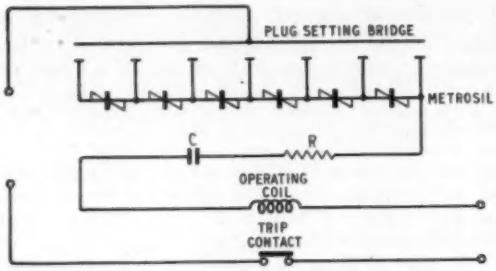


Fig. 3.—Diagram of voltage operated relay for circulating current protection scheme

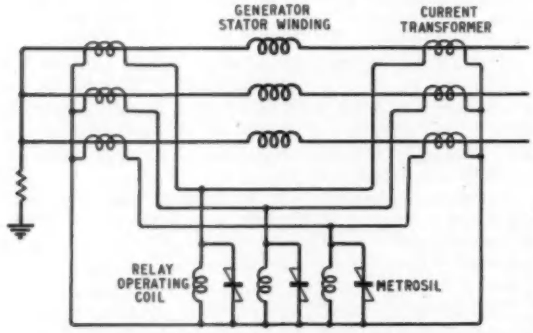


Fig. 4.—Phase and earth fault differential protection scheme

failure on the bearing surface or even displacement of the rotor sufficient to cause bending of the shaft. In addition to the possibility of mechanical trouble, however, there is the further danger of overheating of the field windings and excitation system due to the action of the voltage regulator attempting to maintain the rotor flux in spite of the turns that have been short circuited by the double earth fault.

Loss of Excitation.—Failure of the d.c. excitation causes the machine to behave as an induction generator, the stator drawing magnetising current from the a.c. system with the rotor running at a speed slightly above normal. Owing to non-uniformity in reluctance of the magnetic circuit of the rotor, the stator current will oscillate through an appreciable magnitude at the slip frequency. Operation under these conditions should not be allowed to persist because of the risk of overloading the stator by operating at low power factor and overheating the rotor owing to induced currents in the rotor body and damper winding.

Overload.—A generator operating on a large system under continuous supervision is not in much danger from overloading. The power which can be generated is limited by the steam production, and hence cannot rise unnoticed and be maintained for any appreciable period above the set programme. It is not usual practice to provide overload protection to supervised machines. In this sense overload or over power must not be confused with overcurrent protection which is dealt with later.

Failure of Prime Mover.—In the event of failure of the power source a synchronised generator will continue to run at synchronous speed, drawing power from the system. With certain types of prime mover this situation could lead to mechanical danger, but in general a supervised turbo-generator in a main power station will not pass into this state without the fact being obvious to the control staff. Where circumstances indicate that further precautions are advisable, a reverse power relay can be applied to bring about automatic tripping of the generator circuit-breaker.

Longitudinal Differential Protection

The most satisfactory method of protecting an a.c. generator stator is by the application of a differential scheme using the Merz-Price circulating current principle. For simplicity the basic scheme is shown for one phase in Fig. 2. With ideal current transformers a through primary current would produce in each transformer the same value of secondary current which would circulate as shown, and no current would pass through the relay. If an internal fault develops on the protected winding as indicated by the dotted line, the "entering" and "leaving" currents are no longer equal, the difference passing through the protective relay to cause operation.

Early history with a low-impedance current-operated relay showed instability on through faults. This was overcome, on a more or less empirical basis, either by increasing the coil impedance or by adding "stabilising" resistance in series with the coil. Later investigation showed that increasing the impedance of the relay coil circuit was in effect giving the relay a voltage setting. This led later to the establishment of the voltage setting theory which, briefly, extends the use of stabilising resistance to a logical conclusion; by increasing the relay circuit resistance to a high value and reducing its operating current to a few milliamps the transit from the original conception of a relay with a current setting to a relay with a voltage setting was completed.

It will be appreciated that this transition achieved much more than changing the relay winding. The cause of instability on through faults became understood, and calculation of stability levels in relation to current transformer characteristics firmly established. The basis of the theory assumes that the most adverse condition for balance is when one current transformer becomes saturated due to the d.c. component of an asymmetric fault current. Its output thus disappears and the transformer contributes nothing towards maintaining the relay points at zero potential. In effect, the transformer winding becomes a resistance in the circuit, and the voltage appearing at the relay points is the product of the secondary fault current and the resistance of leads plus saturated transformer winding. A relay voltage setting greater than this product assures stability at the fault current level chosen.

The relay coil is tuned by a capacitor which renders the relay insensitive to the d.c. component of the current. Only the symmetrical component of the fault current need thus be considered when calculating the relay setting. A diagram of connections of a single element is shown in Fig. 3. The series resistors used in conjunction with the tapping bridge are made non-linear, which assists in obtaining high-speed performance.

When used with current transformers having a secondary rating of 1 A, the relay has an operating current of only a few milliamps and it is generally possible to obtain an effective setting of under 10 per cent, thus giving protection to over 90 per cent of the generator winding. It is usual to provide phase and earth fault protection as shown in Fig. 4.

Primary Operating Current.—The method of calculating the minimum primary operating current for either current or voltage operated relays is similar. It is not sufficient to multiply the relay operating current by the current transformer ratio. This is because of the magnetising losses in the current transformers connected in parallel with the relay. The sum of these must therefore be determined at the voltage existing across the relay connection points at the minimum relay operating current and added vectorially to the latter, before multiplying by the current transformer ratio.

Percentage of Winding Protected.—With a knowledge of the earthing resistance employed, the voltage required to pass the minimum primary operating current is readily calculated. This voltage gives the distance from the neutral point at which a fault must be placed to cause relay operation. The winding above this point as a percentage of the total is the percentage winding protected against earth faults. Practically the whole of the winding is protected against phase-phase faults since there is no limiting impedance included in the fault circuit.

Biased Systems.—Present-day knowledge of current transformer behaviour has enabled limitations in the circulating current system to be overcome by use of a high impedance or voltage operated relay as described above. Overall performance can be predicted with confidence, and where an unbiased relay meets the requirements of a particular application a bias feature is superfluous.

Circumstances do arise, however, where, because of excessive lead burdens or practical limitations in current transformer design, performance falls short of requirements and a bias feature becomes necessary. The effect of the bias is to enable the impedance of the relay operating circuit to be reduced for a given value of through-fault stability. The voltage drop across the current transformers is correspondingly low, and the magnetising currents have negligible effect on the primary fault setting.

The bias feature is obtained by circulating the through-fault secondary current through an additional winding which exerts a restraining force or bias on the movement. The basic circuit connections are shown in Fig. 5. Nominally, no current flows in the operating coil under through-fault conditions, but owing to imperfect matching of the current transformers some spill current may be present. This spill current will flow in the relay operating circuit but will not cause operation unless the operating/bias current ratio for which the relay is set is exceeded. The magnitude of the current to cause operation is not constant, but automatically increases as the circulating current increases. This ratio can be determined by considering the forces acting on the relay movement:

$$\text{Operating force} = K(I_1 - I_2)T_o$$
$$\text{Restraining force} = K\tfrac{1}{2}(I_1 + I_2)T_r + S$$

Where T_o and T_r represent turns on operating and restraint windings and S spring restoring force.

The electrical operating and restraint forces are equal at the balance point of the relay, whence

$$\frac{I_1 - I_2}{\frac{1}{2}(I_1 + I_2)} = \frac{T_r}{T_o}$$

This equation shows that the characteristic has a slope determined by the ratio $T_r : T_o$, or with given relay constants the per-unit bias is defined as the difference current divided by the mean circulating current and is a constant ratio for all current magnitudes (see Fig. 6).

The modern version of a relay designed for application of this nature is of the type comprising a permanent magnet with moving coil energised via metal rectifiers which convert the a.c. into d.c. Use of the permanent magnet flux enables sensitivity to be obtained with a low energy input as well as a high ratio of minimum operating current to continuous rating. These features reflect a reduced burden on current transformers, compared with the electromagnetic relay, thus simplifying design problems.

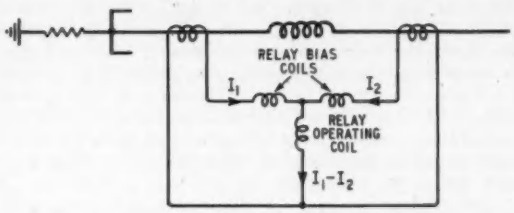


Fig. 5.—Basic circuit of biased percentage differential protection scheme

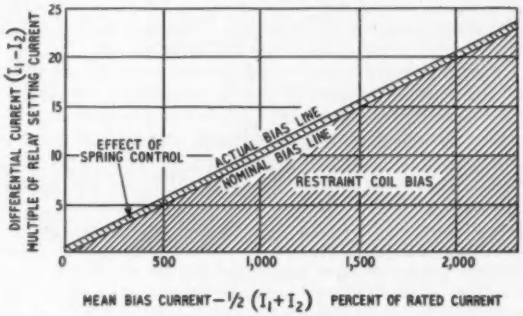


Fig. 6.—Typical restraint characteristic for biased relay

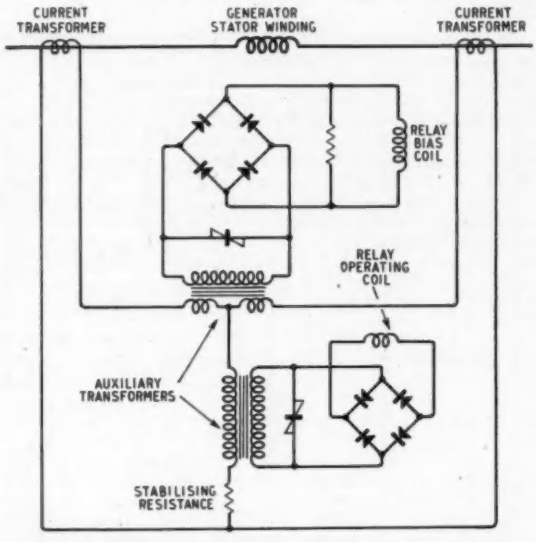


Fig. 7.—Single-phase diagram showing biased relay applied to generator protection

Fig. 7 shows the application to the overall protection of a generator, one relay element being associated with each phase. Relay settings of two per cent of the current transformer rating are possible and for most applications a bias of five per cent is adequate.

Generator-Transformer Units.—Where the generator and generator-transformer are coupled together as one unit the main differential protection is extended to cover both. A bias scheme is essential to counteract the effect of dissimilar ratios and characteristics of the current transformers during through-fault conditions as well as the unbalance caused by power transformer magnetising current and a tap change range of about ±10 per cent.

It is sometimes advocated that harmonic restraint on the relay should be provided to deal with magnetising inrush on the power transformer. Experience, however, has shown this to be unnecessary, because the transformer is magnetised slowly during the running-up period. Furthermore, external faults are cleared at or near current zero, which corresponds to a voltage maximum because of the low power factor, whereas magnetising inrush currents are at the maximum when switching occurs at or near the voltage minimum.

The scheme is shown in Fig. 8, which embodies the same type of relay as already discussed for generators. A relay setting of 20 per cent and a 20 per cent bias setting are adequate for most applications. The diagram also indicates separate balanced earth fault protection for the star-connected high-voltage winding of the power transformer which is usual for this combination.

Earth fault protection of the generator and l.v. windings of the power transformer can be considered on its own merits, as there is no direct electrical connection with the power system. It is usual to earth the neutral point of the generator through a much higher impedance than when the generator is connected direct to the system. Practice varies somewhat in this respect, ranging from the primary winding of a potential transformer with a voltage relay across the secondary to a small power transformer loaded with a resistance on its secondary such that the primary would pass approximately one-fifth full-load current with a full phase-to-ground fault. Instantaneous relays can be employed to trip with equivalent primary settings of about two per cent or, what is perhaps more general, induction type relays are used with a lower setting and a short inverse time delay.

Fig. 8.—Combined generator-transformer protection using biased differential relay with separate balanced earth fault protection for earthed transformer star winding

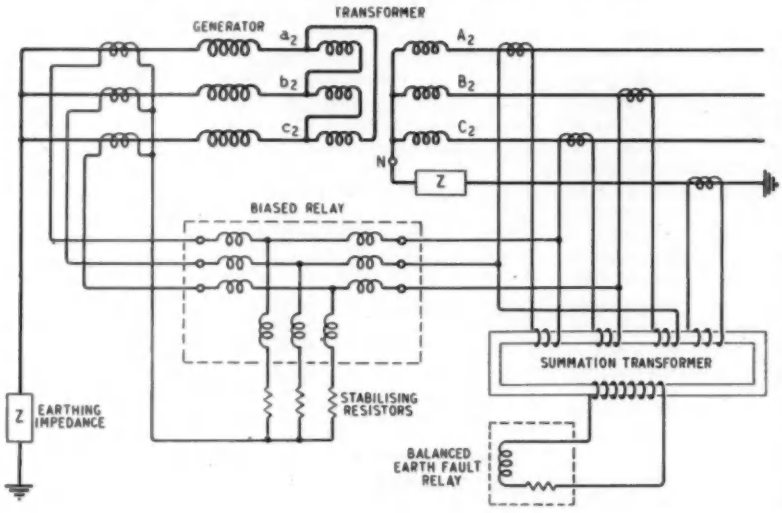
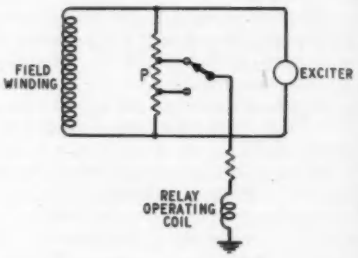


Fig. 9.—Rotor earth fault detection by potentiometer resistance method



Overcurrent Protection

It is usual to employ an induction type inverse-time delay relay as back-up protection for a generator. The operation of this relay is complicated by decrement in the generator circuit. It is important that the generator shall not be tripped as a result of system faults, even though the generator is operating under its maximum excitation condition, and the relay setting must be chosen to discriminate with the outgoing circuit protection. In the event of a close-up uncleared through fault it might be thought that the overcurrent protection would disconnect the generator, but with settings as chosen above, if the generator should be operating with no-load excitation the fault current may decay to a value below that corresponding to the relay setting before the relay has time to complete its necessary travel.

Consequently it is accepted that overcurrent relays are set not so much with the intention of tripping under through faults, but rather to guard against fault current fed back from the system upon the occurrence of an in-zone fault. In this way the overcurrent relay serves as back-up protection to the main system and also provides a very useful standby system of protection for such periods as, for example, when the differential protection is being tested, at which times the overcurrent settings can be varied at discretion to suit the temporary conditions.

These remarks about the decrement in the generator circuit are modified to some extent when automatic voltage regulators are in use, particularly those of the static quick-response type controlling large reserves of excitation power. While the main function of the regulator is to maintain voltage and stability it also means that decrement is delayed, and recent experiments on a large generator have shown that overcurrent/time settings can be chosen so as to give back-up cover against through-fault conditions. Where this arrangement is adopted, however, possible variations in current/time values must be kept in mind when the regulator is out of circuit for maintenance.

An unrestricted earth fault protection consisting of an induction type relay operated from a current transformer connected in the generator

neutral earth connection can provide a useful back-up system both for the generator winding protection and for the busbars and system as a whole. If such a relay is applied it will, of course, be set to operate only in the event of extreme emergency, and to this end it may be desirable to employ a relay having a longer time delay than normal.

Negative Sequence Protection

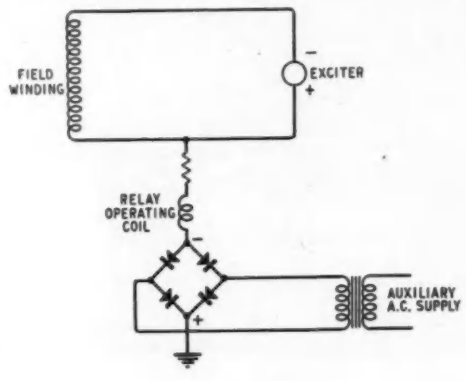
In spite of reluctance in the past it is now becoming recognised that some form of negative sequence or unbalanced loading protection is a necessary feature for generating plant. While system phase/phase or phase/earth faults are dealt with by circuit protection, unbalanced loading can occur as a result of an open circuit on one phase of a transmission line or failure of one phase of a circuit-breaker to close. These possibilities are fortunately rare, but on the other hand, running machines adversely affected by the unbalanced load will suffer damage if the situation is not quickly detected and remedied. It will be understood that the machines in more than one station may fall into this category, and that however drastic automatic tripping may seem the alternative may be widespread machine damage.

Generally, an induction type relay energised from a negative sequence network is employed. The time characteristic is arranged to approximate to that of the machine being protected. Depending upon circumstances a sensitive setting may be used to provide indication to the operating staff that unbalanced loading conditions exist.

Rotor Faults.—Two methods have been adopted of detecting earth faults in the rotor circuit. In the first method a high-resistance potentiometer is connected across the rotor circuit, and has its centre point connected to earth through a sensitive relay (see Fig. 9). The relay will respond to earth faults occurring over most of the rotor circuit. There is, however, a blind spot at the centre point of the field winding, which is at equipotential with the mid-point of the potentiometer. This blind spot can be checked by having a tapping switch to move the earth point from the mid-point of the potentiometer to a point a little to one side, thereby making the system sensitive to a fault at the spot that was formerly blind. The tapping switch can be mounted on the control panel, and this check operation performed at suitable intervals. An alternative method, which completely avoids a blind spot, consists of biasing the field circuit relative to earth by means of a small transformer rectifier unit connected between the positive pole of the field system and earth, a high-resistance relay being included in this connection (see Fig. 10). The positive pole of the field system is biased some 40 V negative to earth, and the remaining portions of the field circuit are proportionately more negative. A fault occurring at any point in the field system will apply a voltage to the relay which is sufficient to cause operation, the fault current being limited to a negligible value by the resistance of the relay. It is usual, but not invariable practice, to connect rotor circuit supervision schemes so as to give an alarm only.

Field Failure.—A current relay in the rotor circuit is usually all that is required to supervise the field system. Because of the control exercised by modern voltage regulators, however, the field current is likely to vary over a wide range, and under certain conditions may swing down to about 20-25 per cent of no-load excitation value. The relay must not respond to these transient effects, and a low setting with a time delay feature is advisable.

Fig. 10.—Rotor earth fault detection by negative biasing method



Conclusions

In reviewing the principal electrical protective schemes applied to steam turbine driven a.c. generators it must not be thought that it is necessary to cover every contingency in every case. The modern generator is a reliable piece of electrical plant, and the various protective features can be looked upon as insurance premiums against acknowledged hazards. Almost every station has its own peculiar circumstances, and while differential protection is regarded as essential the others are mainly optional and selected with discretion.

Factory Accidents and Health

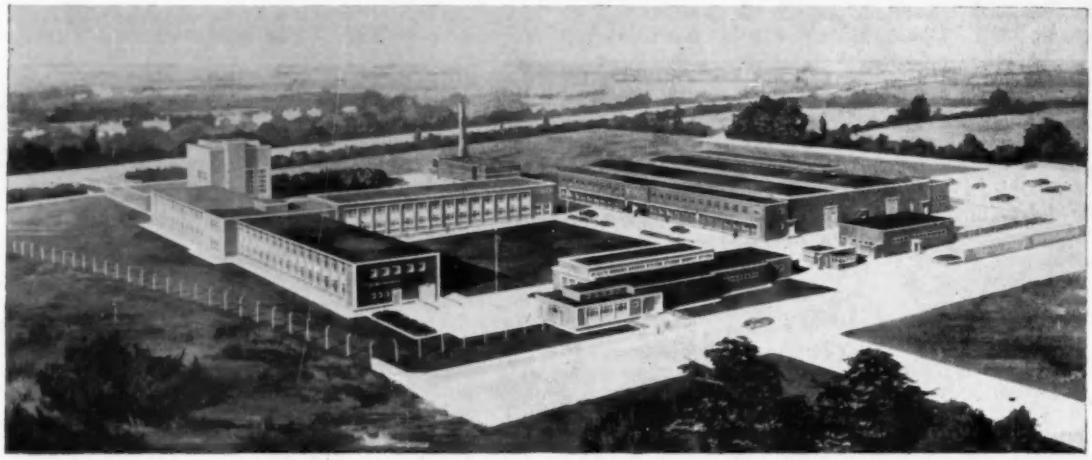
THE number of factory accidents reported in 1958 was 4 per cent less than in the previous year, falling to 167,697, according to the annual report of the Chief Inspector of Factories, which has been published as a White Paper. This is their lowest level for 23 years, although fatal accidents rose from 651 to 665. There is, however, no general downward trend. In both building operations and works of engineering construction there has been an appreciable rise, although there has been no significant increase in the amount of work of this type undertaken.

Of the 714 electrical accidents reported, 38 were fatal, compared with 687 accidents, including 32 fatalities, in 1957. Since the figures for electrical accidents fluctuate from year to year, the report comments that there is probably no particular significance in this increase. Portable and transportable electrical apparatus and associated cables and accessories were concerned in about 40 per cent of the fatal and about one-third of all electrical accidents.

The use of mobile radio links in the maintenance of overhead lines and in constructional work is quoted as an example of electrical apparatus used to assist safe working. A device employed to some extent abroad and proposed for use in this country gives warning of the approach of cranes to high voltage overhead lines, but the limitations of this type of apparatus must be appreciated. In 1958 28 accidents, 19 of them fatal, arose from contact with overhead electric lines.

A separate chapter is devoted to the problems relating to nuclear energy and ionisation radiations, including the electrical instrumentation and control of nuclear reactors, the preparation and fabrication of special metals used in reactors and plant producing ionising radiation.

As last year, a separate report on industrial health has been published dealing with industrial disease, poisoning and gassing. Among the cases of lead poisoning reported were those of a man working on the recovery of lead from scrap cable and five cases arising from the production of lead acid batteries, while the mercury poisoning cases reported included a woman who had been filling mercury switches by hand for some time.



General view of New Parks, Leicester, the headquarters of the A.E.I. Electronic Apparatus Division

A.E.I. Electronic Apparatus Division

NEW HEADQUARTERS AT LEICESTER

THE Electronic Apparatus Division of Associated Electrical Industries, Ltd., has its headquarters in a specially built factory at New Parks, Leicester, which was recently opened by the Minister of Supply, Mr. Aubrey Jones.

The Electronic Apparatus Division integrates the activities in this field of the British Thomson-Houston Co., Ltd., and the Metropolitan-Vickers Electrical Co., Ltd. The executive, who are in complete charge of the Division's activities, are situated at New Parks, and though this is also the centre, within A.E.I., for the development and design of electronic equipment some work will also be continued at Trafford Park, Manchester. The design, development and manufacture of valves and semiconductors is done at Lincoln. Industrial electronic equipment is produced at New Parks and military electronic equipment at Blackbird Road, Leicester. In addition, manufacture for the Division is carried out at Trafford Park, Rugby, and at Coventry. The total floor area available exceeds 800,000 sq ft and the number of persons employed is over 4,000. There is a development, design and engineering staff of some 400, mostly professional engineers, and the laboratory and office space exceeds 100,000 sq ft. Further development of the Division will take place at the New Parks site.

Wiring electronic machine tool equipment

Like the other A.E.I. product divisions the Electronic Apparatus Division has been formed to avoid unnecessary competition between the constituent companies of A.E.I.; to avoid duplication of tools and design; to use the available technical manpower in the most effective manner; and to ensure that the necessary concentration on sales design and manufacture is given to the particular product concerned. The B.T.H. Co. at Rugby will be the Management Company of this Division; it will act as the co-ordinating body with other divisions and provide common services such as accounting (other than works accounting), data storage, etc.

Five Trading Groups

The business of the Division is divided into five trading groups, each of which has a senior engineering, commercial and factory representative in charge, and collectively they are responsible to the divisional executive for the groups' affairs. The *Servo Group* is concerned with servo applications where the servo-mechanism is a separate entity and it also acts as consultant to other groups on servo problems. Among the equipments developed are precision positioning drives for machine tools, automatic-programmed screw-down for rolling mills, large aerial structures, tank turrets, and rod control systems for

nuclear power stations. The *Computer Group* covers both digital and analogue types with immediate applications in business, industrial processes and machine tool control and special military uses. The *Radar Group* has concentrated recently on large ground equipments for fire control, early warning, search and ground-to-air guided weapons; airborne and marine equipments are also handled. The wide range of equipment dealt with by the *Industrial Electronic Control Group* includes voltage regulators for power station and marine generators and aircraft supplies; electronic and magnetic amplifier motor control equipment; static switching systems; automatic positioning and tracer controls for machine tools; welding controls; transistor timers and protective gear; h.f. heating; and communication equipment. The *Industrial Valve and Semiconductor Group* concentrates on valves such as ignitrons, thyratrons, gas-filled rectifiers, magnetrons, klystrons and TR and TB cells, and the semiconductor devices include point contact silicon microwave diodes, point contact and gold-bonded germanium diodes, silicon junction and zener diodes, germanium and silicon transistors and silicon controlled rectifiers.

Modern Plant and Buildings

The site at New Parks covers some twenty acres in an industrial zone provided by the City of Leicester planning scheme to provide employment for residents of two nearby housing estates. The site is on high ground, and the design and amenities of the buildings, together with these other advantages, provide excellent working conditions.

There are at present two main buildings, an office and laboratory block and a factory unit, which with various auxiliary buildings provide a total floor area of 180,000 sq ft. In planning the layout of the buildings thought has been given to possible future developments, and an increase of at least 150 per cent of the present floor space can be provided without difficulty.

The offices and laboratories are in the two-storey "T" shaped building on the left of the photograph. The three wings, which are of similar design, are each 54ft wide and the offices and laboratories on each side of the central corridors are 22½ft wide. The normal module in the other direction is 12½ft and movable partitions give complete flexibility. A false ceiling in the corridors is used for carrying electrical and other services and ducts are included in the floor at every module. Supply and distribution boards are arranged so that any particular supply can be made available at any laboratory bench. The high annexe to the laboratory building is for testing large radar equipments. The canteen building in the foreground is designed as a social centre.

The manufacturing departments are housed in the single-storey building on the right. Vertical roof glazing running north and south along the sides of the two high bays gives ideal natural light to the main production areas. The outer and central bays, with lower roof levels, are used for purposes requiring less critical lighting standards. Light colours are used for decoration and a system of fluorescent lighting, designed to reproduce natural conditions, takes over as daylight fades. Clean air at a regulated temperature is provided by a plenum system.

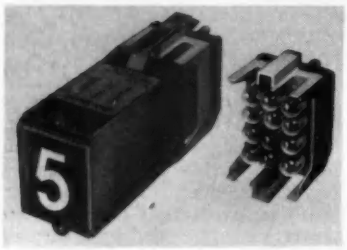
The production plant and equipment includes some of the most modern developments in manufacturing techniques and safety precautions and the various departments have been positioned to eliminate unnecessary movement of materials. The main manufacturing areas require only two three-ton overhead travelling cranes. In addition to the sections engaged in the actual production of industrial electronic apparatus there is a model room where prototypes are built and new techniques, such as printed circuits, investigated. Another pre-production section is engaged in waveguide development. To obtain the great accuracy needed in this work the section has machine tools capable of working to a tolerance of one ten-thousandth of an inch. Where the design is extremely complex the metal is deposited electrochemically on to specially prepared mandrels.

Section of the model room where prototypes are built and new techniques investigated

NEW ELECTRICAL EQUIPMENT

Projection Indicator

A projection indicator announced by R. B. PULLIN & CO., LTD., Phœnix Works, Great West Road, Brentford, Middlesex, incorporates a quick-release lamp unit, fitted with 6·3 V lamps, for easier mounting and lamp changing, and is arranged for flush panel mounting, giving a wide angle of view and improved panel appearance. Figures available are 0-9 inclusive, plus two decimal points, one left, one right, and the figure size is 1·2in high by 0·6in wide.



Pullin indicator

Cable Insulation Tester

An equipment to test the insulation of cable covered with rubber, polythene, p.v.c., etc., has been manufactured to meet the requirements of B.S. 7 : 1953 by MCKELLEN AUTOMATION, LTD., 122, Seymour Grove, Old Trafford, Manchester, 16. The cable is passed through an electrode having a number of small hanging chains maintained at a potential between 300 and 12,500 V at mains frequency. An auto/manual switch is provided on the front panel. In the auto position, an insulation fault closes the detector relay whilst the faulty portion of the cable is in the electrode. An alarm bell is sounded, the fault counter is operated and the winding motor tripped by this closed relay and the test voltage limited to avoid further damage to the insulation. In the manual position, a fault immediately cuts off the test voltage and closes the detector relay until the re-set key is operated. Faults can be precisely located by using a hand electrode. The equipment operates from a 110 V 40-60 c/s or 200-250 V 40-60 c/s supply and has a power consumption of 150 W.

McKellen insulation tester

Automatic Burner Control

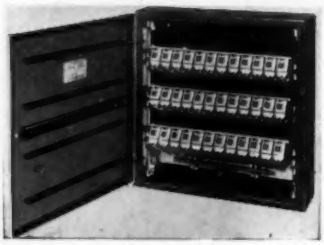
The automatic oil burner control introduced by the Instruments Division of NEWMAN INDUSTRIES, LTD., Yate, near Bristol, is constructed in a standard plug-in sub-unit to facilitate installation and maintenance. It incorporates a photo-electric flame detector and a thermal relay, set during installation, to control the failure-to-ignite time. The starting sequence is initiated by closing a time or thermostat switch. The control, which is housed in a pressed steel case having approximate dimensions of 9in by 5in by 5in, operates from a 110/127 or 210/250 V supply with a power consumption of approximately 4 W during starting.

Newman oil burner control

Fuseboards

The "H.W." range of dust and waterproof fuseboards recently announced by the GENERAL ELECTRIC CO., LTD., Magnet House, Kingsway, London, W.C.2, is rated for use with circuits carrying 20 A up to 550 V. Shields and fusebanks are held by quick release catches, and the fusebanks cant forward ready for wiring, facilitating easy installation. There are no loose screws and neutral bars can be moved without the use of tools. The cases and covers comply with the test for hoseproof enclosures in B.S. 2817 : 1957.

G.E.C. fuseboard



Feedback Wattmeter

The sensitive, iron-free wattmeter developed by H. TINSLEY & CO., LTD., Werndee Hall, South Norwood, London, S.E.25, incorporates three identical coil systems on a common suspension. The voltage and current coils are rated at 15 mA maximum and have resistances of 400 and 40 Ω respectively. One or two systems may be connected to the circuits being measured, the connections being arranged to measure either sum or difference power if both are used. The third system is energised by the feedback current delivered from an amplifier which responds to a light beam deflected by a mirror on the suspension. This current produces a torque which exactly balances that produced by the first and second systems and is a measure of the power.

Magnetic Separator

The magnetic drum type separator announced by ELECTROMAGNETS, LTD., Boxmag Works, Bond Street, Birmingham, 19, is fitted with a drum embodying "Alcomax" permanent magnet alloy units and fitted with a rolled stainless steel cover suitably ribbed to aid separation, the cover being fitted on non-magnetic end flanges mounted on bronze bearings fitted to a steel shaft. The drum, which rotates

Electromagnets drum type separator

at approximately 25 r.p.m., is driven through a V belt by a totally enclosed geared motor mounted inside the machine casing. The drum is supplied from a feed tray fitted with a rotary type vibrator. Both vibrator and drum driving motors are wound for three-phase 50 c/s supplies and are controlled from a single push-button starter provided with a cable entry gland.

Light Vacuum Cleaner

Claimed to be the lightest upright cleaner available (weight 10½ lb), the model 420 Hotpoint cleaner, manufactured by A.E.I.-HOTPOINT, LTD., 33, Grosvenor Place, London, S.W.1, is now in three colours—red, green or

Hotpoint model 420 vacuum cleaner

maroon. The attachments have been completely redesigned and they are now lighter, neater and easier to use than the earlier tools. The new crevice tool, upholstery nozzle and general purpose brush for floors and walls, are in polystyrene, and the hose has a light grey plastic cover. A plastic extension arm is included and among features which are retained is an inner air sleeve. The wheels have a two-position adjustment, and the height of the brush is adjustable in four positions. The price of the cleaner, including purchase tax, is 21 gns plus 4 gns extra for attachments.

Line Earth Loop Tester

An instrument for testing circuits which will carry current to earth in the event of a fault by-passing a current of approximately 20 A when the full mains potential is applied through a circuit consisting of the live conductor, the earth continuity conductor and the earth return path, and indicating path resistance directly, has been announced by EVERSHED & VIGNOLES, LTD., Acton Lane Works, Chiswick, London, W.4.

A ballistic meter is used since the test current is of limited duration. A

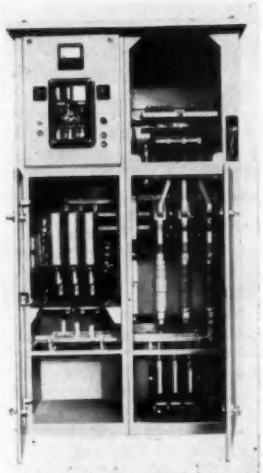
Evershed & Vignoles earth loop tester

synchronous motor drives a contactor which connects a 10 ohm resistor from the live conductor to earth for a period of five cycles, that is 0·1 second. The current during this period is determined by the resistance of the fault loop in series with the 10 ohm resistor, and the meter, which is connected in parallel with the resistor, can be calibrated in terms of loop resistance. A mains voltage selector has been included and an auxiliary voltmeter can be supplied integrally for use where the mains voltage is not known precisely. Three-phase circuits may be tested and the instrument may also be used for determining the earthing efficiency of an appliance.

Contactor Starter

The type K contactor starter designed for the direct-on-line starting of 3·3 kV motors up to 600 h.p., introduced by the BELMOS CO., LTD., Bellshill, Lanarkshire, is housed, complete with control and protective equipment, in a pillar which may be free-standing or grouped with similar units to form a switchboard. The main busbars, fitted when the pillar is in switchboard form, have a continuous rating of 1,000 A and can withstand a through fault of 150 MVA for three seconds.

Belmos contactor starter



The contactor has been tested in accordance with B.S. 775 : 1956 and has a breaking capacity of 1,300 A at 0·25 power factor. Up to five auxiliary switches can be operated by the contactor. The d.c. operating coil is supplied from a germanium rectifier and 3,300/110 V transformer housed within the pillar.

The control arrangements which can be provided include sequence interlocking and automatic sequence starting. Overload and earth leakage protection is provided by a thermal relay while back-up protection is provided by h.r.c. fuse-links with a rupturing capacity of 150 MVA at 3·3 kV. The isolator is fully interlocked and is designed for forward/off/reverse or on/off/earth connection. Up to twelve auxiliary d.c. or a.c. 25 A switches can be fitted.

Conductivity Measurement

The type MC-1 portable electrolytic conductivity measuring bridge, for checking steam condensate and impurities in distilled and demineralised water and for testing the content of solids in boiler and cooling water, introduced by ELECTRONIC SWITCHGEAR (LONDON), LTD., Works Road, Letchworth, Herts., embodies a precision a.c. measuring bridge energised at low potential by a transistor oscillator operating at 1,000 c/s. The output from the bridge is fed through a three-stage transistor amplifier, rectified and applied to a null balance indicator.

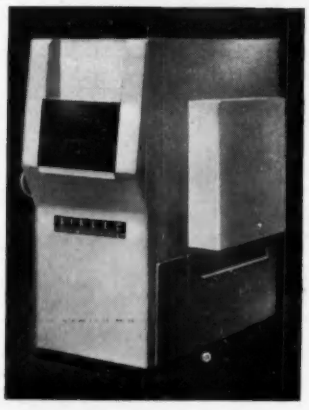
The instrument measures from 0·1 to 100,000 micromhos per cu cm in three ranges. The cell is complete with a connecting lead and polythene end caps, making it suitable for bench or flow line measurements.

Box Furnaces

The designs for standard box furnaces manufactured by BIRLEC, LTD., Erdington, Birmingham, 24, have been re-styled, resulting in a price reduction throughout the range.

The new GP series furnaces are built for two temperature ranges, five type GP1000 furnaces from 1·5 to 25 cu ft capacity with ratings from 20

Birlec GP1400 furnace

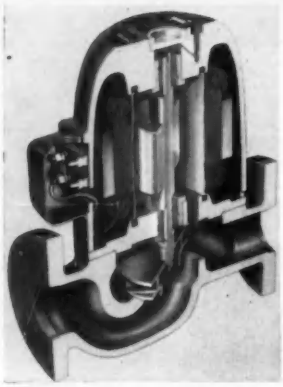


to 70 kW operate at temperatures up to 1,000 deg C, and four sizes of GP1400 furnaces operate at temperatures up to 1,400 deg C. Their capacities and ratings range from ¼ to 3 cu ft and 16 to 60 kW respectively.

A separate control cubicle is provided for each furnace housing a temperature control equipment, main isolating switch, control and safety contactors.

Central Heating Water Pump

In a hot water circulator for small bore central heating systems introduced by COPPERAD, LTD., Colnbrook, Bucks., the motor rotor and the bearings run in water, requiring no lubrication, and there are no glands to cause water leakage. The motor is of the capacitor start-and-run type, operating on 200/250 V single-phase 50 c/s supplies.



Copperad water circulating pump

Sleeve-bearing Motors

The Series 5 range of sleeve-bearing a.c. motors announced by CROMPTON PARKINSON, LTD., Crompton House, Aldwych, London, W.C.2, are rated from 1 to 15 h.p., each having major dimensions complying with B.S. 2960. Although the Series 5 ball-bearing and sleeve-bearing machines are interchangeable for equivalent frame sizes, the shaft diameters of the sleeve-bearing motors are smaller, due to the smaller b.h.p. output per frame size of the sleeve-bearing models. The motors, which incorporate Class E insulation, permitting operation at continuous maximum ratings with a temperature rise of 65 deg C, are of a radially ventilated design.

Crompton Parkinson sleeve-bearing motor

Epoxide Glass Laminate

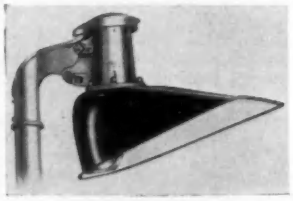
The epoxide glass laminate, DH.19073, recently marketed by BAKELITE, LTD., 12-18, Grosvenor Gardens, London, S.W.1, combines mechanical strength and moisture resistance with good electrical properties. Copper-clad versions are available having 0·0015in or 0·003in copper foil on one or both sides. Full details of this material are given in Advance Information Sheet E.34, copies of which may be obtained from the company on request.

Electronic Invertor

The Mark II "Felgate" electronic invertor announced by RADIO MAILING, LTD., Studland Hall, Studland Street, Hammersmith, London, W.6, is a power source to supply a.c. equipment rated from 20 to 100 W from 210 to 250 V d.c. mains. The invertor, which uses a multi-vibrator circuit driving four valves, has overall dimensions of 10in by 7½in by 6½in and is priced in the United Kingdom at £14.

Overhead Floodlighting

The "Duoflex" overhead floodlight manufactured by the BENJAMIN ELECTRIC, LTD., Tottenham, London, N.17, has now been modified to bring it into the "Model 50" range of lighting fittings announced earlier this year. Diecastings are now used, re-styled for improved appearance and to provide more room for carrying the interior cables into the hood casting. Provision is also made for terminating mineral insulated copper sheathed cables and for adjusting the position of the lampholder to suit different sized lamps, one fitting now covering the 500 to 1,500 W range.



Benjamin floodlight

Photomultiplier Tube

A photomultiplier tube, type 9558B, using a tri-alkali photo-cathode has recently been introduced by E.M.I. ELECTRONICS, LTD., Hayes, Middlesex. The cathode is characterised by a high quantum efficiency of between 15 and 20 per cent in the blue region—at 4,200 Å—and an extended red response up to 8,500 A, while having at the same time a very low value of dark current. A typical tube has a photo sensitivity of 100 μA/L, an overall sensitivity of 200 A/L at an average of 1,700 V and a dark current under these conditions of 0·003 μA. These tubes are especially suitable for application in spectrometry, particularly flame spectrometry, and for scintillation counting with materials such as caesium iodide.

E.M.I. photomultiplier tube

Torque Motors

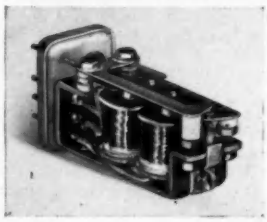
A series of torque motors having high torque output and frequency response, low weight and compact size, has been introduced by the Electronics Division of DE HAVILLAND PROPELLERS, LTD., Manor Road, Hatfield, Hertfordshire. Other design features include impedances to suit transistor, magnetic and valve amplifiers, absence of separate excitation and low hysteresis. Provision is made for differential or series excitation, the former being recommended as it eliminates datum shift caused by supply variations.

Miniature High Speed Relay

A low current version of an existing miniature high speed sealed relay has been developed by SIEMENS EDISON SWAN, LTD., Woolwich, London, S.E.18, with an activated carbon getter inside the container to adsorb the slight organic vapours that remain after sealing which lead to contact contamination.

It is particularly suitable for converting low power d.c. signals into alternating voltages, as required for amplification in computers. Of the single changeover type, the relay is made for various voltages between 1·2 and 48 V d.c. The contacts are of platinum, and contact resistance is less than 0·1 Ω. Weighing under 2½ oz, the type 130 relay measures 2½in by 1 1/16in by ¾in, with terminal pins extending ⅜in. A plug-in base is an optional addition.

Siemens Edison Swan relay



NEW PATENTS Electrical Specifications Recently Published

The numbers under which the specifications will be printed and abridged are given in parentheses. Copies of any specification (3s 6d each including postage) are obtainable from the Patent Office, 25, Southampton Buildings, London, W.C.2

1953

35278. Siemens Edison Swan, Ltd.—Automatic telephone systems. 16th September, 1955. (816131.)

1954

21070. Ferranti, Ltd., and Walker, P. J.—Electrostatic loudspeakers. 19th October, 1955. (815978.)

27712. Siemens Edison Swan, Ltd.—Automatic telephone and like selecting systems. 9th December, 1955. (815979.)

28289. Electric & Musical Industries, Ltd.—Control of machine tools. 21st September, 1955. (816133.)

32818. English Electric Co., Ltd.—Oil-immersed electric circuit interrupters. 11th November, 1955. (816321.)

35836. General Electric Co., Ltd.—Sodium vapour electric discharge lamps. 8th December, 1955. (816043.)

36225. British Telecommunications Research, Ltd.—Telecommunication systems employing automatic gain regulators. 1st December, 1955. (816134.)

1955

3565. Mullard Radio Valve Co., Ltd.—Ultrasonic machining apparatus. 6th February, 1956. (816213.)

3734. British Thomson-Houston Co., Ltd.—Position control servo mechanisms. 8th May, 1956. (816370.)

12838. British Thomson-Houston Co., Ltd.—Electrical relay circuit arrangements employing semiconductors. 3rd May, 1956. (815980.)

18066. Aberdare Electric Co., Ltd., and Greer, P. H.—Heaters for tar, bitumen and the like. 22nd June, 1955. (816103.)

19689. Metropolitan-Vickers Electrical Co., Ltd.—Reduction of vibration transmission from electrical generator and exciter combinations. 18th June, 1956. (816045.)

26848. Pulvari, C. F.—Electrostatic recording and reproducing apparatus. 20th September, 1955. (816109.)

27237. General Electric Co.—Apparatus for frequency measurement. 23rd September, 1955. (815985.)

27468. United Kingdom Atomic Energy Authority.—Logarithmic current amplifying circuits. 27th September, 1956. (816144.)

28007. Libbey-Owens-Ford Glass Co.—Support bodies carrying electrically conducting films. 1st October, 1955. (815986.)

30365. General Electric Co.—Electronic devices. 24th October, 1955. (816328.)

31193. Kelvin & Hughes, Ltd.—Light sensitive devices. 19th October, 1956. (Cognate application 3173, 1st February, 1956.) (815988.)

31375. Solartron Electronic Group, Ltd.—Radar simulators. 24th October, 1956. (Cognate application 27071, 4th September, 1956.) (816218.)

31634. Siemens Edison Swan, Ltd.—Arrangements for circuit selection. 19th October, 1956. (816219.)

34056. Leber, F.—Preselector electric switch mechanism. 28th November, 1955. (816332.)

34172. General Electric Co.—Rectifier cell mounting. 29th November, 1955. (816221.)

35985. United Kingdom Atomic Energy Authority.—Electronic valves. 12th December, 1956. (816333.)

36788. Claude Paz et Visseaux.—Electric discharge devices containing cold hollow electrodes. 22nd December, 1955. (816054.)

1956

191. Collins Radio Co.—Remote control system. 16th January, 1958. (816148.)

4275. Telephone Manufacturing Co., Ltd.—Multiplex carrier telephone systems. 10th May, 1957. (816113.)

6851. General Electric Co., Ltd., and Bown, G. C. S.—Television receivers. 5th March, 1957. (816226.)

6861. Bendix Aviation Corporation.—Semiconductor materials suitable for use in the gap bridge of an igniter. 5th March, 1956. (816060.)

7517. Claesson, P. H. E.—Electric contact spring devices particularly for electromagnetic relays. 9th March, 1956. (816061.)

9171. Illinois Tool Works.—Snap-action electric switches. 23rd March, 1956. (816296.)

9864. General Electric Co.—Silent electric discharge apparatus. 29th March, 1956. (816342.)

10325. Philips Electrical Industries, Ltd.—Electric lamps and discharge tubes. 4th April, 1956. (816229.)

10328. Philips Electrical Industries, Ltd.—Diffraction apparatus for X-rays or gamma rays. 4th April, 1956. (816153.)

11828. Farrant, R. D.—Portable supporting structures for radio or television receivers. 17th July, 1957. (815994.)

13240. General Electric Co., Ltd.—Field exitation arrangements for synchronous electric motors. 26th April, 1957. (816232.)

16143/4. General Electric Co., Ltd.—Electric lighting fittings. 17th and 23rd May, 1957. (816206/7.)

18332. Sperry Rand Corporation.—Magnetic core memory device. 13th June, 1956. (816345.)

23016. Midland Silicones, Ltd.—Electric conductors coated with modified alkyd resin compositions. 25th July, 1956. (816072.)

24340. Carr Fastener Co., Ltd.—Screening cans for thermionic valves, condenser units or other electrical components. 1st August, 1957. (816002.)

26135. General Electric Co.—Armature windings for dynamo-electric machines. 27th August, 1956. (816121.)

26473. Davis & Son Derby, Ltd., J., and Davis, W. B.—Solenoid operated electric bells. 28th August, 1957. (816158.)

26713. Wayne Kerr Laboratories, Ltd., and Calvert, R.—Electrical measuring bridges. 19th August, 1957. (816242.)

27165. Mills, C. G.—Electrical measuring instruments. 3rd December, 1957. (816122.)

27294. Scholes & Co., Ltd., G. H., Pearce, F. J., and Pearce, G. S.—Control of electric appliances. 8th August, 1957. (816301.)

28676. British Thomson-Houston Co., Ltd.—Operating circuits for electric discharge lamps. 11th September, 1957. (Cognate application 34821, 14th November, 1956.) (816302.)

29281. General Electric Co.—Instrument or like suspensions. 25th September, 1956. (816077.)

30417. Cutler-Hammer, Inc.—Electromagnetic contactors with interlock. 5th October, 1956. (816347.)

31132. Chance-Londex, Ltd.—Electric battery assemblies. 11th October, 1957. (816007.)

34983. British Thomson-Houston Co., Ltd.—Electric lanterns for outdoor illumination. 22nd October, 1957. (816078.)

35610. Philips Electrical Industries, Ltd.—Electromagnetic circuit arrangements. 21st November, 1956. (816079.)

35831. United Kingdom Atomic Energy Authority.—Fuel elements. 6th November, 1957. (816124.)

36007. Cole, Ltd., E. K., and Levi, J. E.—Focusing arrangement for cathode-ray tubes. 25th November, 1957. (816080.)

36441. General Electric Co., Ltd., and Speed, R. F. B.—Electric pulse counting circuits. 27th November, 1957. (816487.)

37815. Veb Zeiss Ikon Dresden.—Photo-electric exposure meters or regulators. 11th December, 1956. (816708.)

38207. Proctor Electric Co.—Wattage controller system. 14th December, 1956. (816637.)

39457. Eitel-McCullough, Inc.—Electron tube. 28th December, 1956. (816082.)

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3474. British Oxygen Co., Ltd.—Electric arc cutting. 13th January, 1958. (816255.)

4870. Globe Engineering Co., Ltd.—Electric motors. 17th December, 1957. (816020.)

5440. Brown, Boveri & Cie A.G.—Electrical commutator machine with multiplex winding. 18th February, 1957. (816021.)

5735. Philips Electrical Industries, Ltd.—Colour television systems. 20th February, 1957. (Addition to 776878.) (816258.)

6236. Schulten, R.—Nuclear reactor installations. 25th February, 1957. (816083.)

7111. National Research Corporation.—Vacuum induction furnace. 4th March, 1957. (816261.)

9214. Siemens & Halske A.G.—Circuit arrangements for setting routing selectors in telecommunications installations. 20th March, 1957. (816162.)

9256. Cole, Ltd., E. K., and Pichal, H. T.—Automatic gain control in television receivers. 21st March, 1958. (816355.)

10594. General Electric Co., Ltd.—Clothes washing and drying machines. 1st April, 1958. (816358.)

13866. Ateliers de Constructions Electriques de Charleroi.—Electric remote control positioning system. 1st May, 1957. (816360.)

15538. Allmänna Svenska Elektriska A.B.—Air blast circuit-breaker for high voltages. 16th May, 1957. (816309.)

21981. Allmänna Svenska Elektriska A.B.—Induction motor having an axially movable magnetic armature operating, for instance, a brake. 11th July, 1957. (816190.)

24427. General Electric Co.—Bonding of non-metallic refractory members to metal members. 1st August, 1957. (816032.)

27737. Sodeco, Soc. des Compteurs de Geneve.—Telephone fee pulse counter. 3rd September, 1957. (816194.)

28132. Bosch G.m.b.H., R.—Manufacture of commutators. 6th September, 1957. (816033.)

28166. Allmänna Svenska Elektriska A.B.—Air blast circuit-breakers in which drying air is delivered to the control air pipe. 6th September, 1957. (816315.)

29426. General Electric Co.—Mica paper. 18th September, 1957. (816316.)

30693. Mullard, Ltd.—Photo conductive photo electric cells. 1st October, 1957. (816195.)

31120. Ruben, S.—Potential producing electric cell. 4th October, 1957. (816036.)

31796. Compagnie Générale de Télégraphie sans Fil.—Image transforming apparatus. 11th October, 1957. (816197.)

33833. Yale & Towne Manufacturing Co.—Power operated lifting truck. 30th October, 1957. (816097.)

33978. Creed & Co., Ltd.—Tape feeding devices. 31st October, 1957. (816098.)

36351. Maschinenfabrik Oerlikon.—Air cooled single anode rectifiers. 21st November, 1957. (816099.)

38150. Bosch G.m.b.H., R.—Commutators. 9th December, 1957. (816198.)

CONTRACT INFORMATION

Accepted Tenders and Prospective Electrical Work

CONTRACTS OPEN

Where "Contracts Open" are advertised in our "Official Notices" section the date of the issue is given in parentheses.

Australia.—State Electricity Commission of Victoria, Melbourne. 2nd September. Two 66/11 kV transformers and spares. (E.S.B. 19823/59. Ten/41330.)*

Postmaster General's Department, Melbourne. 3rd September. P.v.c. adhesive backed tape. (E.S.B. 19127/59. Ten/41091.)*

Birmingham.—Public Works Committee. 22nd September. Group "A" street lighting equipment. (See this issue.)

Chile.—Direccion de Aprovisionamiento del Estado, Santiago. 3rd September. H.v. underground cable. (E.S.B. 18418/59. Ten/41190.)*

India.—India Supply Mission. 29th September. Coal loaders, electric locomotives and coal cutters. (See this issue.) 23rd October. Airport lighting equipment. (See this issue.)

National Coal Development Corporation (P), Ltd., Calcutta. 28th September. Ninety-two 3·3 kV oil circuit-breakers. (E.S.B. 19139/59. Ten/41133.)* 29th September. Lighting cable. (E.S.B. 19141/59. Ten/41143.)*

Madras State Electricity Board. 14th September. A.c.s.r. and all-aluminium conductors and conductor accessories. (E.S.B. 19252/59. Ten/41267.)*

Bihar State Electricity Board, Patna. 7th September. Pin, strain and post insulators. (E.S.B. 19903/59. Ten/41362.)*

Iran.—Plan Organisation, Tehran. 7th September. Electrical installations for the town of Anar. (E.S.B. 19310/59. Ten/41188.)*

Italy.—Ministero Difesa, Aeronautical, Rome. 10th October. Forty-nine 45 kW frequency convertors. (G.D. 5373/59. Ten/41381.)*

Korea.—Office of Supply, Seoul. 9th September. Building materials, including electrical equipment. (E.S.B. 19560/59/I.C.A. Ten/41327.)*

Northern Ireland.—Down County Education Committee. 10th September. Electrical installation in Newcastle (New) Primary School. Barrett & Agnew, consulting engineers, 420, Ravenhill Road, Belfast.

Pakistan.—Director General, Posts and Telegraphs, Karachi. 8th September. Detectors and avometers. (E.S.B. 19555/59. Ten/41274.)* 9th September. Porcelain insulators. (E.S.B. 19088/59/I.C.A. Ten/41110.)*

Portuguese East Africa.—Ports, Railways and Transport Department, Lourenço Marques. 23rd September. Two 40 kVA generating sets. (E.S.B. 18921/59. Ten/41102.)* 28th September. Electrical equipment for power plant of railway workshop compressors. (E.S.B. 18922/59. Ten/41092.)*

Repton.—R.D.C. 9th September. Group "A" street lighting equipment. (See this issue.)

Rhodesia and Nyasaland.—Federal Tender Board, Causeway. 4th September. H.v. overhead line materials. (E.S.B. 19645/59. Ten/41304.)*

South Africa.—Mossel Bay Municipality. 6th September. Coal handling plant for new power station at Little Brak River. (E.S.B. 19076/59. Ten/41186.)*

Durban Electricity Department. 11th September. One 10 MVA transformer. (E.S.B. 19722/59. Ten/41315.)*

Union Tender Board, Pretoria. 9th September. Communication equipment, isolating transformers and public address equipment. (E.S.B. 19507/59. Ten/41275.)* 11th September. Two radio receivers and one transmitter. (E.S.B. 19506/59. Ten/41258.)*

Thailand.—Thai Technical & Economic Committee, Bangkok. 8th September. Two 3,750 kVA power transformers. (E.S.B. 19074/59/I.C.A. Ten/41120.)*

United States.—Bureau of Reclamation, Denver. 10th September. One 12,000 h.p. and one 6,800 h.p. hydraulic turbines, governors and shut off valves. (E.S.B. 19007/59. Ten/41149.)* One 9,600 kVA and one 5,400 kVA generators. (E.S.B. 19219/59. Ten/41174.)*

* Specifications may be inspected at the Export Services Branch, Board of Trade, Lacon House, Theobald's Road, London, W.C.1 (Chancery 4411; extension 769).

ORDERS PLACED

Douglas (Lo.M.).—Corporation. Recommended. Provision of 130 lanterns complete with colour corrected mercury vapour lamps and control gear (£6,853).—Revo Electric Co., Ltd.

Esher.—U.D.C. Accepted. Installation of additional lighting and power points in pre-war Council houses (£5,386).—R. Giddings & Co., Ltd.

Kendal. — Corporation. Recommended. Installation of improved street lighting on the remainder of the main traffic routes in the borough (£10,437).—Walker Installations.

Wallasey.—Corporation Housing Committee. Accepted. Electrical installations in 74 maisonnettes at Church Street (£3,737).—Hartley Electromotives, Ltd.

WORK IN PROSPECT

Particulars of new works and building schemes for the use of electrical installation contractors and traders. Publication in this section is no guarantee that electrical work is definitely included. Alleged inaccuracies should be reported to the Editors

Barnet.—Dwellings (193), Whitings Hill estate; U.D.C. surveyor.

Blackburn.—High school for girls, Witton Park; borough engineer, Town Hall.

Bracknell.—Infants' school, Bullbrook area (£44,655); Berks. county architect, Wilton House, Parkside Road, Reading.

Bradford.—New blind welfare centre, Morley Street/Claremont site (£37,000) and extensions to Regional College of Art (£80,000); W. Clifford Brown, city architect.

Burnley.—Head office block, Red Lion Street and Parker Street, for Borough Building Society, Ltd.; John Dickinson & Co., Ltd., Fairclough Street, Bolton.

Carmarthen.—Extensions to Trinity College; Architects Co-Partnership, 44, Charlotte Street, London, W.1.

Connah's Quay.—Swimming bath and assembly hall; J. G. L. Poulson, architect, 29, Ropergate, Pontefract.

Cookham. — Houses (42), Whiteladyes Lane; Halfacre & Young, Ltd., Holyport Road, Maidenhead.

Crook (Co. Durham).—Houses (50), Watergate estate; Page, Son & Hill, architects, 75, King Street, South Shields.

Crosby.—Houses (78) and flats (40), Edge Lane Estate, Thornton; Harold O. Roberts, town clerk, Town Hall, Waterloo, Liverpool, 22.

Croydon.—Houses (111), as first stage development of site opposite Central Parade, New Addington; borough engineer, Town Hall.

Derby.—Twin operating theatre for Royal Infirmary; J. H. Fryer, Ltd., Great Northern Road.

Dewsbury.—Boiler house and extensions at Town Hall; R. M. Thompson, Ltd., Circle House, Lady Lane, Leeds, 2.

East Barnet.—Houses (65) on site near Brunswick Park Road; C. M. Barnes, surveyor, Station Road, New Barnet, Herts.

Essex.—Extensions to St. Osyth's Training College, Clacton (£298,730) and Gilbert Technical School, Colchester (£80,000); county architect, County Hall, Chelmsford.

Fife.—Secondary school at Macedonia, Glenrothes. Modernisation and extension, Hillend School; R. S. Lawrie, county architect, County Buildings, Cupar.

Isle of Ely.—Hereward boys' school, March; county architect, County Hall, March, Cambs.

Leeds.—Development plan for the Whinmoor area, which will provide for the erection of over 1,000 dwellings, shops, schools, etc.; city architect, Priestley House, Quarry Hill, 9.

Leicester.—Works and offices, Warrington Street; Cravens, Ltd., 313, Saffron Lane.

London.—Office block, 18/26, Ludgate Hill; Colonial Mutual Life Assurance Society, 4, St. Paul's Churchyard, E.C.4.

Showrooms and offices, High Road, Chiswick; Richard Costain, Ltd., 111, Westminster Bridge Road, S.E.1.

Theatre and offices, Lisle Street, Leicester Square, W.; Carl Fisher, architect, 56, Portland Place, W.1.

Loughborough.—Works, Regent Street and Union Street; Loughborough Glass Co., Ltd., Willow Works, Derby Road.

Lymington. — Houses (32), Broomfield Lane and Hillside Road sites; A. L. Slater, town clerk, Town Hall.

Manchester. — Workshops, offices and garage, Trafford Park Road; Springfield Warehousing & Wharfage Co., Ltd., Ordsall Lane, Salford.

Oxford.—Houses (79), site at St. Ebb's. Houses (44), Barnes Road extension site; E. G. Chandler, city architect, Town Hall.

Peterborough. — Modernisation of St. Mark's primary school and new assembly hall and kitchen (£20,000); Portess & Richardson, architects, Cathedral Gateway, Peterborough.

Royton.—Houses (82) and four shops, Birchinlee, for U.D.C.; Heywood & Ogden, architects, 12, Clegg Street, Oldham.

Rugby. — Showrooms, warehouse and offices, Corporation Street; Travis & Arnold, Ltd., West Bridge, Northampton.

Sheffield. — Workshops and warehouse, Scotland Street; Small & Parkes, Ltd., 103, Eyre Street.

Slough.—Laboratories for I.C.I., Ltd.; Holland & Hannen and Cubitts, Ltd., 1, Queen Anne's Gate, S.W.1.

Stamford.—Houses (44) on land adjoining King's Road, for B.C.; F. J. Lenton & Partners, architects, 16, Broad Street.

Stanmore.—Fire station in Honeypot Lane (£57,500); Middlesex county architect, 1, Queen Anne's Gate Buildings, London, S.W.1.

Sunderland. — Extensions to Central Library, Museum and Art Gallery (£75,000); D. & J. Ranken, Ltd., Stockton Road.

Taunton.—Warehouse and offices; Walpamur Co., Ltd., 149, East Reach.

Tipton.—Flats (48), Aston Street; borough engineer.

Werrington.—First instalment of new primary school (£61,400) for Peterborough Joint Education Board; Portess & Richardson, architects, Cathedral Gateway, Peterborough.

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